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CALCIFICATION AND OSSIFICATION OF THE KIDNEY

A REVIEW OF THE LITERATURE AND A REPORT OF CASES

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PART II[2]

(*D*) *Vascular Diseases of the Kidney*

1. Arterial Calcification.—Arterial calcification has attracted much attention in recent years. This phenomenon is observed in the two main types of arteriosclerosis. In the atherosclerosis type, calcification appears to be limited to the intima, whereas in the medial calcification —so-called Monckeberg's disease—these changes are observed chiefly in the media. In both types, calcification has been produced experimentally by adding acid or alkali to a high calcium diet (Rabl), by administration of parathormone (Huepner) and by injection of irradiated ergosterol (Kreitmar and Moll). Isolated or disseminated calcification of the arterial system may occur in the various bone diseases (Barr and Charles) and may be unaccompanied by calcium deposits in other organs. On the other hand, this type of calcification has been reported in combination with metastatic calcification of the kidney, lungs, and stomach by Schultze in a case of osteosclerosis and by Schmidt in severe nephritis.

The most familiar example of arterial calcification in the kidney is the calcified pipestem renal arteries associated with generalized arteriosclerosis. These calcified arteries are seldom visualized in the plain roentgenogram, probably due to the fact that the amount of calcium salts deposited in the arterial walls is insufficient to cast a shadow through the overlying tissues. The authors have had the opportunity of examining the roentgenograms in 15 cases of extensive calcification of the abdominal aorta reported by Feldman and one case of calcification of an aneurysm of the abdominal aorta, and in none of these cases was there any roentgenographic evidence of calcification of the renal arteries. The calcifying process not only involves the main renal arteries but also the large intrarenal branches of these arteries. In 1931, Fish and Hallock reported a case of calcification of the intrarenal arteries so extensive as to give the roentgenologic appearance of calculi or tuberculosis. The correct diagnosis in their case was established at autopsy when, in addition to sclerosis and calcification of the renal arteries and their branches, calcification of the aorta and carcinoma of the lung with metastases were found. Recently Tillier reported aortic calcification simulating calculi of the ureters in a case of renal lithiasis.

Calcification may also occur in the renal veins, as indicated by the report of Sterling

[2] See classification, Part I, page 549.

and Lawrence, in 1924. They observed calcification of the renal veins in a case of bilateral nephrolithiasis in a female, 51 years old, who had passed small calculi for the past 20 years. No other calcification was noted in the kidney.

2. Aneurysm.—A rare and bizarre type of calcification of the renal vessels is the calcification of an aneurysm of the renal artery. In 1932, Mathe collected 55 cases of aneurysm of the renal artery and added one case. Calcification was noted in 11 cases, to which may be added the case reported by Wesson and Fulmer (1933). Calcification may occur in either the true or false aneurysm, but most frequently in the former type. The presence of calcareous deposits in the case of a true aneurysm of arteriosclerotic origin may be interpreted as part of the general calcifying process of arteriosclerosis, whereas calcification of walls of a false aneurysm is a retrogressive process due to replacement changes in the surrounding tissues which contain extravasated blood.

The calcareous deposits in the walls of the aneurysm may produce an opaque ring-like shadow in the renal region on the roentgenogram, offering a difficult problem in differential diagnosis, as the condition is easily confused with shadows of a renal calculus, calcified abscess, calcified cyst, or calcified lymph node. Several writers, including Key and Akerlund, Soderlund, Mathe, and Wesson and Fulmer, consider the wreath-like ring-shape shadow with a relatively denser peripheral zone to be characteristic of calcified aneurysm of the renal artery. The calcified shadow is usually situated at the hilum of the kidney but occasionally is found within the kidney outline, since the aneurysmal process may involve intrarenal branches of the main artery.

(*E*) *Injuries of the Kidney*

There is a decided paucity of reports dealing with renal calcification of traumatic origin. In many of the classical articles on injuries of the kidney, no mention is made of calcification as one of the late sequelæ. It is indeed very likely that many cases of calcification following kidney injuries are encountered but either are not recognized as such, being confused with calcification in other pathological renal lesions, or are not reported. Colston has emphasized the etiologic rôle of trauma in the production of calcified renal and perirenal cysts.

1. Intrarenal Calcification.—The extent of calcification following kidney injuries is dependent upon the condition of the kidney before the injury, the type of kidney injury, amount of hemorrhagic extravasation, and the interval of time elapsing before the examination is made. While the majority of small subcapsular hematomas and parenchymal effusions are readily absorbed, the larger collections of blood within the parenchyma or in the perirenal space are not always entirely absorbed and may undergo degenerative changes. The extravasated blood in or about the kidney coagulates, clots, and adheres to the surrounding tissue and calcium salts are precipitated from the organized blood clot. The site of the calcium salts may be precipitated within the parenchyma or upon the walls of a perirenal cyst. Every intrarenal or extrarenal hematoma provides fertile soil for the growth of bacteria derived from a pre-existing renal lesion or distant focus of infection. As a result of the infectious process, there may develop a variety of unpleasant sequelæ, namely, cortical or subcapsular abscess, perirenal abscess, pyonephrosis, in any one of which calcification may occur.

2. Extrarenal Calcification: (a) Perirenal Hematoma.—In our search of the literature, we found that the earliest reports of calcification following a kidney injury were made by Abbot in 1902. Pathological examination of the operative specimen disclosed the mass to be an old excapsulated perirenal hematoma which had undergone extensive calcification. An almost similar case of calcified perirenal hematoma has been reported by Fleischer and Hansen (1935).

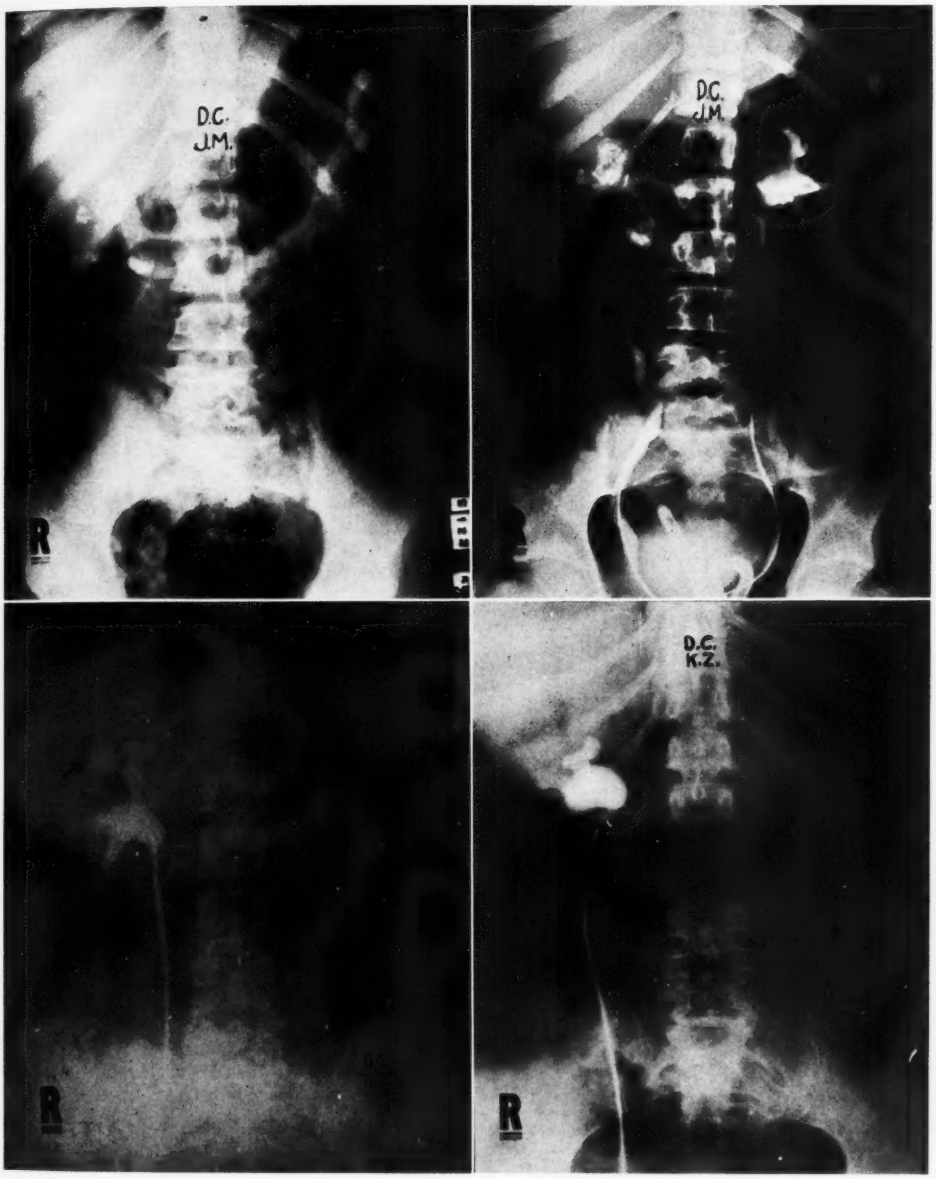

Fig. 18 (*upper left*). Case XVIII. Plain roentgenogram showing several irregular areas of calcification in the region of the right kidney following an injury to the kidney one year previously.

Fig. 19 (*upper right*). Case XVIII. A bilateral pyelogram showing a moderate hydronephrosis (left). The dye was irregularly dispersed in the right kidney and partly obscured the calcified shadows noted on the plain film. The operative specimen disclosed an acute and chronic pyelonephritis with an old laceration in the upper pole of the kidney. Many old organized blood clots containing calcium deposits were found in the pelvis.

Fig. 20 (*lower left*). Case XX. A pre-operative pyelogram of right kidney with arrow pointing to a calcified shadow which was present in the cortical area and did not appear to be connected with the upper calyx or pelvis. This same shadow was present in the plain film. A diagnosis of cortical stone was made and confirmed upon operation. The large calcified shadow seen in the left kidney region proved to be a calculus in the pelvis of the lower and larger half of a double kidney.

Fig. 21 (*lower right*). Case XX. A post-operative pyelogram taken after removal of the cortical stone in the right kidney.

(*b*) *Peripelvic and Pseudo-hydronephrotic Cysts.*—Wesson recently reported a case of perirenal calcification in a boy eight years old following traumatic rupture of the kidney pelvis. The extrarenal mass was a perirenal cyst or pseudo-hydronephrosis. Strauss (1931) described a case of calcification in a pyonephrotic kidney in an adult male following severe injury to the chest and back.

Case XVIII (G. U. 1,446), J. M., male, 17 years of age, student, was admitted to Sinai Hospital on Sept. 10, 1933, with a complaint of pain in the right upper quadrant. In November, 1932, he had sustained an injury to the right loin during a football game. He had hematuria lasting two days. On Sept. 3, 1933, he was struck in that region during a boxing match and had a dull pain, accompanied by hematuria, lasting one day. On Sept. 6, 1933, he developed a sudden stabbing pain in the right upper quadrant, radiating to the right lower quadrant and lasting several hours. This was followed by a dull pain and was accompanied by nausea, vomiting, chills, and fever. He also complained of burning, frequency, urgency, and dysuria. Physical examination disclosed fullness in the right loin and upper quadrant, with tenderness and rigidity in the same region. There were no definite masses palpable. The urine contained an occasional red blood cell and pus cell, and a stained smear showed numerous staphylococci.

Cystoscopy and pyelography on Sept. 11, 1933, revealed a non-functioning kidney on the right side. A plain roentgenogram showed a large, diffuse, blotchy, calcified shadow in the upper pole of the right kidney, an oval shadow in the mid-portion, and an irregular group of calcified shadows in the lower pole (Fig. 18). The pyelogram revealed the opaque medium irregularly dispersed through the entire kidney with no distinct outline of the pelvis or calices (Fig. 19). A diagnosis of non-functioning calculous pyonephrosis with calcification of old blood clots was made. On Sept. 14, a right nephrectomy was performed, after which the patient made an uneventful recovery; he was discharged from the hospital on Oct. 4, 1933.

Pathological examination of the operative specimen revealed an enlarged soft kidney with marked inflammatory reaction in the peripelvic and perinephritic tissues. There was a collection of old blood and pus under the capsule over the upper pole of the kidney. When the kidney was opened, about 200 c.c. of thick pus escaped, leaving a grumous material and organized blood clots containing calcareous material. After removing the débris, an old laceration, 1.5 cm. in length, was found in the upper pole extending from the cortex to the pelvis. Microscopic examination of the tissue removed from various portions of the kidney showed typical changes associated with acute and chronic pyelonephritis.

F. Renal Lithiasis

1. Microlithiasis.—This condition may be considered as a form of calcification of the renal tubules. It is characterized by the presence of minute calculi with the lumen of the collecting tubules. It is rather surprising that this subject is not mentioned in many textbooks (Keyes, Guiteras, Kelly and Burnam, Young) or in monographs on lithiasis (Joly). However, in recent years, the condition has gained some recognition, and contributions have been made by Braasch, Crabtree, Huggins, Higgins, and others.

Microlithiasis must be differentiated from the laminated deposits of uric acid (the so-called uric acid infarcts) seen in the collecting tubules of very young infants at autopsy, and from metastatic calcification of the renal tubule observed in the various bone diseases.

It is difficult to determine the actual incidence of microlithiasis, as extensive pathological and statistical studies are not available. The condition has not been described in children, probably due to the fact that histopathological studies in renal lithiasis in children are seldom made, or else the condition is not recognized. Crabtree found three instances of microlithiasis in a series of 36 nephrectomized kidneys,

19 of which were removed for stone. Huggins observed microlithiasis in two patients who presented osseous metaplasia associated with calculous disease. Higgins found microliths in four of 16 kidneys (of adults) removed for lithiasis. Such high figures lead one to believe that the condition occurs more frequently than is generally believed. Inasmuch as these tubular calculi cannot be detected by our present urological and roentgenological diagnostic measures, it is conceivable that the condition frequently passes unrecognized or unsuspected, with the ultimate result that these minute calculi are passed spontaneously or serve as nuclei for the recurrence of calculi.

The pathogenesis of microlithiasis has not been clearly established. The condition has been observed not infrequently in many cases of experimental renal lithiasis. It has been found after intravenous injections of uric acid and some of its constituents by Heidenhaim, Ebstein and Nicolaier, and Minkowski; after parenteral administration of oxamide and intravenous injection of oxalates by Ebstein and Nicolaier, Keyser, and Huggins, and in vitamin A deficiency by Van Leersum. The various theories which have been proposed to explain the occurrence of larger renal calculi are also offered as an explanation of microlithiasis, but clinical and pathological substantiation of these hypotheses is still lacking.

Unfortunately, bacteriological studies in these cases have not been made except by Crabtree, who found a *B. coli* infection in three cases. It is extremely difficult to draw any conclusions from these meager findings but undoubtedly infection occasionally does play a rôle in the development of microlithiasis.

Faulty urinary drainage resulting from obstruction and stasis has been emphasized by Braasch and Crabtree as a possible factor in the development of microlithiasis. Braasch maintains that dilatation of the tubules resulting from faulty drainage is a necessary prerequisite of microlithiasis. Crabtree found some form of obstruction in each of his three cases. The obstruction may be due to an aberrant vessel of the ureteropelvic junction on occlusion of a calyx by a stone or stricture, or a localized lesion of the papillæ such as a papillitis or fibrosis. In 1913, Caulk reported a case of obstructive calcareous papillitis which resulted in the formation of a non-calcified cyst, the size of a walnut, limited to the affected pyramid. He attributed the obstructive calcareous papillitis to either a primary calcium infarct with gradual deposition of salts and secondary sclerosis or to a primary necrosis with sclerosis and secondary calcification. On the other hand, Huggins maintained that microliths are not found where there has been much necrosis of the papillæ from the pressure of a hydronephrosis or infection.

In this connection, it is interesting to note that Randall has recently stressed the rôle of minute papillary and calyceal lesions in the formation of renal calculi. He pointed out that the initiating lesion is usually found either at the tips of the papillæ, within or around the tubules, or in the calyceal mucosa about the pyramids, and this lesion serves as a focal point for the precipitation of crystalloids or colloids (usually calcium phosphate or oxalate). At first the deposits of calcium phosphate or oxalate are usually subsurface, being intratubular or extratubular, but later the plaque becomes denuded of its overlying epithelium and serves as a nucleus for further deposition of salts.

On gross inspection of kidney surface in cases of microlithiasis, no unusual changes are observed. On cross-section, a gritty sensation may be imparted to the knife and inspection of the cut surface may reveal minute white (calcium) deposits confined to the tips of the papillæ, but occasionally pyramids stand out clearly because of the punctate or linear deposits in them. In many instances, the microliths are not recognized unless serial sections of the pyramids are made.

These minute calculi are usually found within the lumen of the straight collecting tubules and occasionally in the convoluted

tubules and loops of Henle. The tubules appear dilated and the tubular epithelium and basement membrane show no evidences of calcification but present changes of an acute or chronic inflammatory nature. The microliths appear as finely granular casts having a concentric lamellar arrangement similar to that observed in larger renal calculi. They are composed of calcium phosphate or carbonate, are usually of microscopic dimensions but may attain a size of 1 × 0.5 mm. or even larger. These microliths can readily be differentiated from the other calcium deposits of renal tubules by the fact that the latter are usually found outside the tubules, *i.e.*, beneath the basement membrane and rarely in the lumen and they never present a concentric lamellar arrangement.

Case XIX (G. U. 98A), A. B., male, 35 years of age, single, physician. His past history was essentially negative except for an osteomyelitis involving the lower end of the right radius and ulna at the age of five, and a non-specific epididymitis right, prostatitis, and seminal vesiculitis at the age of 29. In April, 1934, he developed hematuria which persisted for six days. He had several attacks of sharp pain in the right upper quadrant and right loin, radiating downward to the right groin. A voided specimen of urine shows 15 to 20 red blood cells and an occasional pus cell. Physical examination was essentially negative.

Cystoscopy and pyelography were performed on April 10, 1934, and revealed several groups of small calcified shadows in both kidneys. These shadows were found to be in the parenchyma of the kidney in the pyramids immediately adjacent to the tips of the calices. The patient subsequently was put on an acid-ash-producing diet with a high content of vitamin A. He received several dilatations of both ureters and passed three small stones which contained mixed phosphates. On Oct. 10, 1935, he complained of sharp pain in the right kidney region accompanied by chills, fever, and hematuria. Plain roentgenogram at this time revealed an oval shadow in the region of the pelvis of the right kidney and a calcified shadow about the size of the head of a match in the upper pole, and a smaller shadow in the lower pole of the left kidney. Following conservative treatment he had hematuria, chills, and fever which subsided. The same dietary restrictions as before were enforced. The infections of the prostate and seminal vesicles were treated at regular intervals.

On June 23, 1936, the patient had an attack of right renal colic with hematuria, and passed a small stone (about the size of a pea) and another smaller stone (about the size of the head of a match). In March, 1937, a left nephrolithotomy was performed and a large stone removed.

2. Cortical Stones.—These stones are of two types: partially or completely encysted. It is generally recognized that the majority of the cortical stones are of the partially encysted variety. In this type the dilated terminal portion of the minor calyx containing the stone usually retains its connection with the major calyx and pelvis, despite the fibrous or cicatricial changes, and the formation of the stone is governed by the usual factors concerned in the formation of renal calculi.

In the completely encysted type of cortical stone, cyst formation may be primary and stone formation secondary. The cyst formation may be due to a variety of lesions; (*a*) occlusion of a minor calyx by chronic inflammatory changes in and about the terminal calyx; (*b*) cystic degeneration following trauma or intrarenal hemorrhage; (*c*) cystic degeneration of the parenchyma as a result of a vascular occlusive phenomenon; (*d*) cystic degeneration within the parenchyma, especially the cortex, as a result of an acute or chronic infection, *i.e.*, chronic pyelonephritis, localized circumscribed abscess; (*e*) cystic disease, *i.e.*, congenital polycystic type; simple serous or hemorrhagic cysts. Stone formation may occur within any of these cysts as a result of degenerative changes and in many instances it may be accompanied by or be secondary to cal-

cified changes in the cyst wall. Braasch recently described an interesting case operated upon for infected hydronephrosis in which the kidney contained several cortical cysts. One of the cysts contained a calculus, 1 × 2 cm. in size, and an adjacent cyst contained an organized blood clot. The presence of calculi within a solitary cyst has been reported by Cunningham, Roberts, and Langfeldt. In Cunningham's case, the calculi were found within a calcified cyst.

The cortical stones are usually asymptomatic and may be present for a considerable period of years, until accidentally disclosed during roentgen study for some other coincidental disease. Cortical stones are not always recognized roentgenographically, being most frequently confused with calcification of solitary tuberculous abscess.

Case XX (G. U. 1,052), K. Z., female, 53 years of age, married, housewife, was first examined on Jan. 2, 1925. She gave a history of repeated attacks of pain in the right upper quadrant and right lumbar region, radiating to the right shoulder and accompanied by chills and fever.

On Jan. 4, 1925, cystoscopic study revealed a calculus in the lower right ureter which was passed following several ureteral dilatations. She subsequently developed left kidney colic in January, 1929. On Nov. 12, 1927, cystoscopic and pyelographic studies revealed a calculus in the upper pole of the right kidney which appeared to be in the cortical zone (Fig. 20). A large coral calculus was found in the lower—and larger—half of a double kidney on the left side. Both kidneys were severely infected and showed a marked reduction in function. On Dec. 20, 1927, a right nephrolithotomy was performed. The calculus was found completely encysted in the cortical area adjacent to the upper major calyx. There was about 2 mm. of tissue separating the stone from the kidney capsule. The stone was round and measured 2.5 × 1.4 cm. No communication was found between the cystic cavity and the upper major calyx.

On June 22 1933, she developed signs and symptoms of a left perinephritic abscess secondary to calculous pyonephrosis of the lower half of the double kidney. Immediate operation was advised, but refused. At operation ten days later, a large collection of thick green pus (about three quarts) was found around the left kidney, and drainage was instituted. The patient died on the third post-operative day, of sepsis. At autopsy, the chief findings were confined to the left double kidney, the upper rudimentary segment of which appeared to be normal while the lower segment was a massive multilocular pyonephrosis and contained a large branched calculus that had ulcerated through the posterior wall of the pelvis.

3. Putty-like Formations.—In 1930, Braasch called attention to three unusual types of urinary calculi which are occasionally present in the kidney, and which he considered to be not true calculi but semicalcified bodies, *viz.:* (1) putty-like bodies, (2) masses of sandy material, and (3) semiorganized blood clots with calcareous deposits.

These soft masses are composed of necrotic tissue, desquamated epithelial cells, a few red or white blood cells, and a small amount of mineral salts. Their shape conforms to the cavity in which they are found. They are usually multiple, and are most frequently found in the terminal calices, where they appear as grayish-black or dark brown oval or spherical masses varying in size from that of a pea to that of a marble. Occasionally, they may form a complete cast of the pelvis or ureter. They are usually associated with chronic infectious process in the kidney, such as a pyonephrosis or chronic suppurative pyelonephritis. The authors have frequently encountered these putty-like bodies in simple pyonephrotic and calculous pyonephrotic kidneys, their presence being unsuspected prior to operation despite careful roentgenographic studies.

The shadow-casting properties of these

putty-like bodies depend upon the amount of calcium present. The shadows of semi-calcareous bodies may be easily confused with true renal calculi containing a mini-

Fig. 22. Case XXI. A plain roentgenogram showing an enormous enlargement of the right kidney containing several large stones (*C*) surrounded by myriads of small pinhead-sized calcified shadows (*B*). In the right ureter below the sacro-iliac joint, there is a large oval shadow (*A*) which on close inspection appears to be a conglomeration of small calcified bodies. There are several large stones in the left kidney (*D*).

mum amount of calcium salts or with the irregular or spotty areas in renal tuberculosis or neoplasms. A pyelogram may be of value in the diagnosis of these putty-like bodies. The non-radiable type may produce filling defects in the outline of the pelvis or calyx, while the radiable type presents a softer shadow which stands out in contrast to the dense shadow of the opaque pyelographic medium.

These putty-like bodies must not be confused with the so-called "putty kidney" known as "*degenerescense massive du rien* of Tuffier," which is considered a pronounced form of occluded renal tuberculosis with massive destruction and calcification of the kidney.

4. Sandy Material.—The presence of loose granular material in the pelvis or calices is not an infrequent finding at autopsy, or at operation for lithiasis. In such cases, it is difficult to state whether the sandy material is due to the granular disintegration of a soft or loosely constructed stone or represents the early stage in the formation of an organized stone. The presence of larger particles in the infected cases of renal lithiasis, as in the authors' case, apparently is due to calcification of the purulent necrotic débris which accumulates within the pelvis or calices as a result of stasis and obstruction. The size of the individual granules varies from fine dust-like substance to pillets resembling caviar or small buckshot. These granular particles contain a varying amount of organic and inorganic salts and consequently produce bizarre shadows or irregular density in the roentgenogram.

Case XXI. H. W., male, 52 years of age, married, clerk, was admitted to the Church Home and Infirmary on the service of Dr. Amos F. Hutchins, to whom we are greatly indebted for the permission and courtesy of reporting this case. The patient's chief complaint was pain in the right upper quadrant and right lumbar region. He had his first attack of right renal colic six years before; four years before he developed a dull sticking pain in the right upper quadrant; for the past six months he had also complained of sharp pain in the penis on voiding, frequency, nocturia, urgency, and tenesmus. On several occasions in the past four years he has had hematuria.

The positive findings on examination were a marked loss of subcutaneous fat, a left hydrocele, and a mass in the right upper quadrant. The mass was about the size of a man's head, and was tender. The urine gave a positive test for albumin (3 plus) and microscopically showed 15 to 20 pus cells, an occasional red blood cell, and many triple phosphate crystals. On admission, the blood N.P.N. was 125 mgm. per 100 c.c., the blood urea 87.40 mgm., blood creatinine 212 mgm. These tests were repeated at intervals of from three to four days and showed a slight but definite increase of the various nitrogenous

retention products. On July 27, 1936, the blood calcium was found to be 12.5 mgm. and the blood phosphorus 3.7 mgm. On admission, the phthalein test showed a 3 per cent excretion for the first hour and a similar amount for the second hour.

On July 16, 1936, cystoscopy and pyelography were performed. The plain roentgenogram showed an enormous enlargement of the right kidney which contained several huge stones and myriads of small pinhead calcified shadows surrounding the larger stones (Fig. 22). In the right ureter below the lower end of the right sacro-iliac joint, there was a large oval shadow which appeared to be a conglomeration of numerous smaller shadows. There were several large stones in the left kidney area (Fig. 22). The following pre-operative diagnosis was made: (1) nephrolithiasis, bilateral; (2) right ureteral calculus; (3) calculous pyonephrosis, non-functioning.

On July 27, 1936, a right nephrolithotomy was performed. The large stones and a large quantity of pus were evacuated. In the lower portion of the kidney there was about a pint of sand and gravel which had the appearance of caviar. The patient died about two hours after the operation.

A partial autopsy was obtained and performed shortly after death. The right kidney contained several large calculi and showed extensive pyonephrotic changes. A very large amount of small black calcareous concretions, resembling small shot in appearance, was found lying in the pelvis and upper pole of the kidney; a larger stone measuring 3 cm. in length was found and trapped at the terminal calyx. Throughout the kidney there were numerous abscesses containing thick greenish pus. The left kidney also contained several large calculi and presented a moderate degree of pyonephrosis.

IV. CALCIFICATION OF THE KIDNEY ASSOCIATED WITH GASTRO-INTESTINAL DISEASES (TYPE II)

(*A*) *Pyloric Obstruction.*—The interrelationship between pyloric obstruction and calcification of the renal epithelium was first noted in 1904, by Nazarro, who found degenerative changes in the renal epithelium and calcareous infiltration in the tubules. His findings were made at autopsy in two cases of pyloric obstruction due to chronic gastric ulcer and accompanied by excessive vomiting and tetany. Oppenheimer (1923) reported 34 cases of punctate calcium deposits in a series of 347 autopsies and observed calcium deposits in three of seven cases of carcinoma of the stomach and in one case of duodenal ulcer. Brown, Eusterman, Hartman, and Rowntree (1923) reported 11 cases of renal insufficiency due to duodenal intoxication and complicated by gastric tetany. A severe toxic nephritis with granular and lipoid degeneration of the tubular epithelium and, with one exception, calcareous deposits in the tubules, was found at autopsy of the six fatal cases. Zeman, Friedman, and Mann (1924) found identical changes in four fatal cases of pyloric obstruction, of which two had gastric tetany. They considered the renal condition to be a toxic degenerative nephrosis, and produced similar renal lesions in 11 of 13 cats by ligating the pylorus. Cooke (1930) reported similar findings in six cases of pyloric obstruction and vomiting due to gastric ulcer or carcinoma, and attributed the renal changes to the alkalosis. Recently Perez-Castro reported similar cases.

(*B*) *Intestinal Lesions.*—Calcification of the renal tubules has also been observed in patients with dehydration, alkalosis, and hypochloremia due to diseases of the intestinal tract. In 1907, Glaserfeld studied the autopsy findings in 70 children and found calcium infarcts in 30 cases, of which 24 died of gastro-intestinal diseases and six of other diseases, namely, bronchopneumonia, tuberculosis, and sepsis Lightwood (1930) reported six cases of gastro-enteritis and vomiting in infants, who showed calcification of the renal tubules at autopsy. Butler, Wilson, and Farber (1936) observed similar changes in a young boy who succumbed to an upper intestinal obstruction and mesenteric

thrombosis. We have observed a case of calcification of the kidney, secondary to a carcinoma of the sigmoid, in a patient who had urinary changes suggestive of a chronic nephritis

Case XXII (Med. 14,383), S. S., male, 72 years of age, married, retired tailor, was admitted to the medical service of the Sinai Hospital on Dec. 31, 1936. He had been troubled with chronic constipation for more than twenty years but for the past two weeks he had complained of six to eight watery stools daily, often colored with fresh blood. He also complained of recent loss of weight, anusea, and anorexia. Physical examination was essentially negative. The laboratory studies revealed a marked degree of anemia. The urine showed a trace of albumin, and microscopically contained granular and hyaline casts, and red blood cells. The patient's condition was too precarious to permit a barium enema; he died on Jan. 8, 1937. An autopsy, performed six hours after death, revealed a large fungating carcinoma of the sigmoid, with perforation and involvement of an adjacent loop of ileum. The left kidney showed an extensive calcareous papillitis of pyramids in the lower pole of the kidney.

(*C*) *Cirrhosis.*—In a series of 507 autopsies, Goldschmidt (1913) found calcium deposits present in 44 cases of cirrhosis of the liver, absent in four cases of cirrhosis, and in other diseases in only three cases.

(*D*) *Dysentery.*—Schmidt (1920) reported a case of extensive calcification of the kidneys, observed at autopsy of a soldier 37 years of age, who had died from heart failure during an attack of infectious dysentery. The renal calcification was superimposed upon a grave lesion of the epithelium of the renal tubules. The author was of the opinion that the degenerative renal lesion in this case was not the direct result of the infectious dysentery and referred to other probable etiological factors, namely, cardiovascular disease and the use of betanaphthol as a skin ointment. He believed that the betanaphthol, which is a well known renal poison, undoubtedly increased the effect of the infection upon the kidney. He also noted that the degeneration and necrosis of the renal tubules in this case did not differ from the findings in grave cases of sepsis or typhoid fever in which no calcification occurs. He maintained that the specific factor responsible for development of calcification of the damaged renal epithelia in one disease and not in the other is the lesion of the colonic mucosa, which results in a disturbance of calcium excretion in the large bowel and of calcium elimination through the kidney.

(*E*) *Undetermined Type of Gastro-intestinal Diseases.*—Butler, Wilson, and Farber (1936) reported the presence of deposits of calcium salts within and adjacent to the collecting tubules of the renal pyramids in four infants and one child, who presented what they considered to be a new clinical syndrome. The important clinical features were: (1) persistent dehydration in the absence of excessive diarrhea and vomiting and in the presence of adequate food, salt, and fluid intake, and (2) a persistent hypernea, associated with a sustained elevation of serum chloride concentration and reduction of serum bicarbonate content. No evidence of hyperparathyroidism was found in any of the cases. It is rather striking that each patient gave a history of an acute upper respiratory disease at the onset of the illness and died of a terminal pneumonia. It is possible that incipient renal lesions developed during the course of the acute upper respiratory disease and, as the disease progressed, more extensive changes, including calcification of the tubules, occurred in the kidneys.

In each of the aforementioned alimentary diseases, it appears that the calcification of the renal tubules is the result of a disturbance in the excretion of calcium, in contradistinction to the type of calcification observed in bichloride of mercury or other metallic poisoning, in which the calcification is secondary to necrosis of the cells, especially of the convoluted tubules. The calcium salts are deposited between the tubular epithelium and the basement

membrane. The calcium deposits are never seen in the form of a layer surrounding the tubules or the blood vessels in the stroma. In the early stages, the calcium salts are laid down as small spheroidal or globular deposits and later appear as conglomerate masses. These calcium deposits do not cast a shadow on the roentgenogram nor are they discernible to the naked eye on microscopic examination. Histologically, it is relatively simple to distinguish this type of calcification from that occurring in bichloride of mercury and other metallic poisoning. In the latter type, the calcium deposits appear as formless masses or casts in the lumen of tubules or in the necrotic tubular epithelium.

(*F*) *Dietary Deficiencies and Faulty Nutrition.*—There is much clinical and experimental evidence to establish a definite relation between renal calculi and faulty nutrition, particularly an imbalance in vitamins causing defective mineral metabolism. However, little evidence has been offered to show a causal relation between renal calcification and dietary deficiencies.

In 1924, Rabl was able to produce calcium deposits in the kidneys in mice experimentally by feeding an acid or alkaline or alternating diet. The calcification was most marked in the zone between the cortex and the medulla. Calcium deposits were also observed in the epithelium and lumen of the tubules, both in the cortex and medulla. He attributed the calcification to a renal lesion with decreased phosphorus elimination, and maintained that when the p_H of the blood is raised by giving foods containing an abundance of bases, the excess calcium is deposited in the tissues.

Mendel stated that the cells of the renal tubules seem to become calcified in some instances when rats are deprived of vitamin A for long periods. De Ruyter recently published photographs of calcification of the tubular epithelium in such cases.

Van Leersum observed calcium deposits in the kidney of 88 per cent of the rats fed on a vitamin A deficient diet. The calcium deposits were found in the epithelium and lumen of the convoluted Henle's loops and in the straight collecting tubules. The author maintained that the calcium deposits passed out of the tubules into the pelvis to act as foreign bodies for the further deposition of inorganic salts. Murata observed calcification of the kidney tubules in animals fed on a vitamin C deficient diet. Jackson stated that calcium deposits in the kidney may be produced by feeding animals a diet deficient in fat. On the other hand, Dixon and Hoyle reported calcium deposits in the kidney, lungs, stomach, and heart of rabbits and guinea pigs fed on a well balanced mineral and vitamin diet to which an extremely large dose of vitamin D in the form of viosterol was added. Similar experimental changes were noted by Kreitmar and Moll, Pfannensteil, and Smith and Elvove. Clinical cases of calcium deposits in the kidney due to irradiated ergosterol have been reported by Putschar, Bills and Wireck, and Thatcher.

Calcium deposits in the kidney have been observed clinically in relatively few nutritional diseases, aside from those bone diseases caused or accompanied by a deficient nutrition. Schmidt pointed out that these calcium deposits are frequently found in the kidneys in gout. Walsh and Norton reported three cases of massive renal calculi in association with pellagra and one case with pernicious anemia, but failed to mention the occurrence of calcium deposits in the renal parenchyma in these diseases. Turner has shown that since certain pellagrins have some elevation of the blood calcium, one might expect calcium deposits in the kidney. Unfortunately, pathological studies of the kidneys in these diseases are not available.

V. MISCELLANEOUS GROUP (TYPE II)

(*A*) *Leukemia.*—Warthin (1907) reported two cases of leukemia treated by roentgen ray in which deposits of lime salts were found in the kidney. On cross-section of the kidney, he found whitish areas and stripes which corresponded to the tubules in the cortical and medullary

Fig. 23. Case XXIII. A plain roentgenogram showing the large triangular shadow of a stone in the pelvis of the right kidney and several small calcified areas in the cortical area.

zones. This was confirmed by histological study, which revealed calcium salts in the lumen and replacing the epithelium of the distal convoluted and straight collecting tubules. He failed to find any evidences of calcification in 25 other leukemics not treated by roentgen ray. He also studied the experimental effect of the roentgen ray on the kidneys of rabbits and mice, but was unable to produce calcification. Verse (1910) described a case of myelogenous leukemia in which calcification of the kidney was limited to a few areas in the cortex. Numerous tubules showed calcified masses in the lumen. The glomeruli and arteries showed no calcification. Wells (1915) reported a case of myelogenous leukemia which showed calcification in the kidney as well as in the endocardium, pulmonary veins, and cardiac arteries. It is possible that the disease produced toxic changes in the kidney of an indeterminable nature which may interfere with the excretion of calcium from the kidney and influence its deposition in the kidney. Further support of this premise is found in the report of Butler, in 1924, who pointed out that hypercalcemia may also occur in leukemia.

We have observed a case of chronic lymphoid leukemia, accompanied by a large calculus, and diffuse calcification of the parenchyma of the right kidney, in a patient who had no roentgen therapy prior to diagnosis.

Case XXIII (Med. 91,287), R. L., female, 50 years of age, married, housewife, was admitted to the medical service of Sinai Hospital on May 5, 1937. Her chief complaint was pain in the left side of the neck, left shoulder, and left arm, for the past ten years. In the past five years she has had a chronic productive cough which was preceded by an attack of pleurisy. In the past month, she has had pain in her right kidney region and periodic attacks of hematuria.

Physical examination disclosed an enlarged spleen, general glandular enlargement, general arteriosclerosis, and chronic bronchiectasis. The leukocyte count varied between 50,000 and 84,000, and the smears showed 80–84 per cent small lymphocytes. A diagnosis of chronic lymphoid leukemia was made. The urine showed an occasional trace of albumin and many red blood cells. Intravenous urographic studies revealed a large triangular shadow in the region of the pelvis of the right kidney, with diffusely scattered patches of calcification in the cortical area of the same kidney (Fig. 23). The patient was discharged from the hospital on May 17, 1937, after which she received intensive deep roentgen-ray therapy, but succumbed in the Fall of 1937.

(*B*) *Senile Type.*—The age incidence was studied by Beer in 1904, and by Oppenheimer in 1923. Beer reviewed 100 autopsies and found calcium deposits in 53 cases. He stated that microscopic deposits are practically always found in old age, whereas such deposits are invariably absent in young individuals. At age 25 to 35, there is a gradual shift from the

negative to the positive phase. In his series of 53 cases, there were only 13 cases below 40 years of age; the youngest patient was 25 years of age. Beer maintained that there was no relation between senile atrophy of the skeleton and calcium deposits. Oppenheimer reported 34 cases of calcium infarcts in 347 autopsies, and found seven cases (20.6 per cent) below 50 years of age and 27 (29.4 per cent) over 50 years. On the other hand, Glaserfeld found 30 cases with calcium infarcts in 70 autopsies on children under two years of age.

From these studies, it would appear that age influences the production of these deposits only insofar as it predisposes to the development of such diseases as cause local changes in the kidney of either a nutritional or toxic nature. The most common disease of old age associated with these deposits is arteriosclerosis. Oppenheimer found arteriosclerosis in 21 of the 34 cases of calcium deposits. It is interesting to note that Glaserfeld found calcification in the peripheral arteries of 42.9 per cent of 70 autopsies in children. It seems likely that renal calcification is frequently encountered in many nutritional diseases to which the aged and feeble are susceptible, but unfortunately detailed observations of these cases are not available.

OSSIFICATION OF THE KIDNEY—OSSEOUS METAPLASIA

Although calcification of the human kidney has been frequently observed in a variety of osseous, renal, and alimentary diseases, ossification of the kidney is a rare pathological finding. At first glance, this appears rather surprising inasmuch as there has been established a very close inter-relationship between calcification and ossification in general and more specifically in the urinary tract.

Heteroplastic bone formation in the urinary tract has been the subject of much experimental study, and those particularly interested in this phase are referred to the excellent and comprehensive articles by Huggins, and by Jones and Roberts. In the brief review presented by the authors, attention is directed to those experimental studies dealing with ossification and calcification of the kidney.

In 1859, Blessig was the first to demonstrate calcification in the kidney of a rabbit four to six days after ligation of the renal artery. Wells, Holmes, and Henry (1911) showed that calcification of the kidney may develop following a temporary interference of the blood supply of the kidney. They were able to demonstrate calcium deposits in the kidney 36 hours after a temporary anemia (ligation of pedicle) for one hour. The calcification occurred in and around necrotic tubules chiefly in two zones, *viz.*, beneath the cortical surface and at the base of the pyramids. Temporary ligation of the renal artery for seven weeks resulted in a heavy deposition of calcium salts such that 25 per cent of the dry weight of the kidney was due to calcium phosphate.

Sacerdotti and Frattin (1901) reported the occurrence of calcification and ossification (formation of bone and bone marrow) in the kidneys of three of four rabbits, 74 to 85 days following permanent ligation of the renal vascular pedicle. The bone was found beneath the mucosa of the pelvis, with spurs extending into the remains of the kidney. In two rabbits the ureter was also ligated, but bone formation was observed in only one rabbit in which a portion of pelvic epithelium persisted. Pocharissky (1905) reported similar results following ligation of the renal pedicle in three of five rabbits. Maximow (1905) reported the occurrence of bone formation as early as five weeks after ligation of the vascular pedicle, and described the process in connection with his work on the histogenesis of blood cells. Liek (1906) observed that bone formation was routinely obtained in the pelvis of the rabbit's kidney within from 16 to 20 days, providing the kidney was wrapped with omentum to secure a free collateral circulation. He found that without this collateral circulation, it required about three months for ossification. He failed to obtain bone formation in four

rabbits in whom a high ligation of the ureter was performed, as well as ligation of the vascular pedicle.

Each of the foregoing investigators stressed the amount of blood supply as a primary factor in pathological ossification of the kidney. Although Liek stated that the presence of young connective tissue near the site of calcium deposits was a necessary requirement for bone formation, and commented upon the relation of bone to the persistence of pelvic epithelium, he did not associate the latter two factors.

Pearce (1909) observed bone formation following excision of the lower pole (approximately one-half) of the kidney, with suture, in six of 19 rabbits' kidneys. He attributed the bone to a metaplasia of connective tissue associated with a proliferation of the epithelium of the pelvic mucosa. The metaplasia of the connective tissue into bone was studied from a histogenetic standpoint by Asami and Dock (1920). They found that ossification occurred in the loose connective tissue beneath the pelvic and calycial epithelium independently of calcification of the parenchyma. They concluded that ossification following ligation of renal pedicle occurred as a result of: (*a*) activity of young fibroblasts beneath pelvic epithelium which accumulated to form a membrane-like structure resembling periosteum; (*b*) direct ossification of hyaline connective tissue in continuity with prepared bone, and (*c*) erosion of lime plaques and laying down of lamellar bone by cells derived from fibroblasts. Huggins (1930) demonstrated the osteogenic properties of the epithelium of the renal pelvis, which he maintained was the primary factor in the formation of bone following the ligation of the renal pedicle. He also observed bone formation beneath pelvic mucosa following fulguration of the renal pelvis with electric current of high frequency in two of three dogs, and following application of 95 per cent phenol to the pelvic mucosa in one dog. Huggins attributed the osteogenetic process to a metaplasia of the connective tissue directly into bone as a result of the influence of newly formed proliferating epithelium of the pelvic mucosa.

The unusual osteogenic properties of the tissues of the urinary tract was first demonstrated experimentally by Strauss. He studied the repair of ureteral defects in dogs by transplanting pedunculated flaps of tissue from the abdominal walls, which consisted of transversalis muscle, fascia, and peritoneum, and found that in every instance a layer of bone formed in that portion bordering on the lumen of the ureter, converting the ureter into a rigid tube. Neuhof repaired defects in the bladder of dogs by transplanting strips of fascia lata and found ossification of that portion of the graft bordering on the lumen of the bladder. Calcification appeared six days and ossification 17 days after operation. Beyond this date, an epithelial lining grew in from the margins and covered the bony surfaces. In neither Straus' nor Neuhof's experiment was there any associated stone formation by encrustation of the bony surface. The calcified and ossified flaps were attributed to the deposition of calcium salts in the necrotic tissues of the fascial patches in contact with the acid urine. In 1923, Phemister repeated the experiments of Neuhof on dogs with essentially the same results. He attributed the ossification to the deposition of calcium salts from the blood and lymph in the portion of transplant bordering on the lumen where the nutritional conditions are poorest, necrosis is greatest, and the acidity of the tissue is increased by the acidity of the urine. Phemister extended his observations to rabbits and sheep, which are herbivorous animals with an alkaline urine as opposed to the acid urine of dogs, and failed to obtain ossification of the fascial patches. Axhausen transplanted the gastric and vesical mucosa to the peritoneal cavity in 16 dogs. The transplants were made to the outside of the stomach or urinary bladder and were permitted to stay for from 14 to 70 days. The formation of a cyst, lined by epithelium, occurred, but no bone formation was observed.

Huggins made an intensive study of the relationship of osteogenesis and certain epithelia. He was able to produce bone formation in a fascial transplant to the bladder of a dog, in whom the urine was diverted by transplanting the ureters to the groin, and thus proved conclusively that urine was not a factor in the production of bone in this location. He also obtained true spongy bone around a transplant of either vesical, ureteral, or renal pelvic epithelium to certain parietal fasciæ, *i.e.*, rectus sheath, fascia lata, subcutaneous tissue, and to certain muscle and synovial membranes. Similar transplantation of the cortex or medulla of the kidney or of the prostate did not result in the formation of bone. He also noted that osteogenesis did not occur following transplantation of gall bladder, gastric, jejunal, and colonic mucosa, adrenal cortex, dura mata, or bone shavings into the rectus sheath. The transplantation of epithelium from the urinary tract into the kidney, spleen, and liver also failed to produce bone. He showed that it was the newly formed proliferating urinary epithelium and not the non-proliferating part of the transplant into rectus sheath that was the essential factor in the osteogenetic process, and that another probable factor was the secretion of fluid containing a relatively large amount of calcium and phosphorus into these epithelium-lined cysts resulting from the transplants of urinary tract epithelium into the rectus sheath. Having demonstrated the osteogenetic power of the renal pelvic mucosa, he maintained that this was the probable factor causing bone formation after ligation of renal pedicle in the rabbit.

Several theories have been advanced to explain heterotopic bone formation in the soft tissues. The periosteal theory, which explains the formation of osseous spurs directly connected with bone, is obviously not applicable to bone formation in the kidney. The neoplastic theory offers a plausible explanation of the occurrence of bone in the relatively rare cases of mixed tumors of the kidney which are of mesoblastic origin and present unusual embryonal and blastomatous features. The metaplastic theory of Leriche and Policard adequately explains most cases of heterotopic ossification of the kidney, particularly these occurring in the human and associated with pre-existing renal lesions. They have pointed out that fibrous tissue, cartilage, and bone are the end-products of a common mesoblastic stem, and that under certain exceptional circumstances any connective tissue may revert to an embryonal state and assume new functions and properties, *i.e.*, fibroblasts may become osteoblasts and form true bone. Confirmation of this theory is found in the heterotopic formation of bone in the experimental animal following the ligation of the renal vascular pedicle and following transplantation of the epithelium of the renal pelvis, ureter, or bladder into the rectus sheath, which has been shown by Huggins to be dependent upon a metaplasia of connective tissue (ossifying fibrocytes) under the influence of newly formed proliferating epithelium. Huggins believed that phosphatase probably played some rôle in heterotopic ossification as in normal bone formation.

It is readily apparent that the same two factors (ossifying fibrocytes and proliferation of epithelium) which explain experimental heteroplastic bone formation, suffice to explain the occurrence of bone in the diseases of human kidney pelvis. Stuart and Kirkorian have maintained that any infective or irritating process in the kidney pelvis, *i.e.*, stones or infection, first causes a proliferation of the renal pelvic epithelium, which, in turn, is followed by osseous metaplastic changes in the connective tissue beneath the pelvic mucosa.

In view of the ready availability of calcium and phosphorus in the urine and the experimental demonstration of unusual osteogenic properties of the epithelium of the renal pelvis, one would expect ossification of the human kidney to be frequently encountered. However, in reviewing the literature, one finds only an occasional report of the occurrence of true osseous tissue

in the following renal diseases, *viz.*: lithiasis, tumors, infarct, hydronephrosis, and pyonephrosis. The majority of recent textbooks and monographs on urology and pathology fail to mention its occurrence. In the older textbooks by Rayer, Roberts, and Dickinson, ossification of the human kidney is mentioned as a rare finding, but from histological studies it is evident that many of these so-called cases of ossification are, in reality, cases of calcification. For example, Rayer described a type of ossification of the kidney called "osteides," which possessed a fibrous structure, was traversed by blood vessels, contained calcium deposits, and was separated from the renal tissue by a membrane. He considered "osteides" to be analogous to the fibrous bodies in the uterus and noted their occurrence in "acephalocysts" (hydatid). From this description it would appear that "osteides" have been confused with calcification of the walls of a hydatid cyst.

(*A*) *Hydronephrosis or Pyonephrosis.*—The earliest case of ossification of the kidney, according to Rayer, is the case published by Vincent in 1889, in which the kidney weighed one and a half pounds and was of cartilaginous consistency. Rayer also cited a case reported by Fearon of a female, 50 years of age, who had died after an anuria of six days' duration. Postmortem examination failed to disclose a kidney on the affected side, but in its place was found an ossified substance. Rayer also reported a personal case occurring in a female, 50 years of age, who had a tumor in the left hypochondriac region; at postmortem examination, the left kidney was found to contain a calculus in the midportion and in the lower pole there was a cartilaginous formation with osseous foci.

Roberts commented upon the fact that sometimes the fibrous septa which separate the pus pockets in a pyonephrotic kidney become extensively calcified and occasionally ossified. He cited an unusual specimen which was sent to him for examination by Dr. John Mudd, of Manchester. A saw was required to cut across the kidney. A piece of one of the bony septa, which was ground down and examined under a microscope, showed the characteristics of true bone, though in a rudimentary state. He also cited a specimen of similar osseous transformation of the kidney preserved in the museum of the Manchester Infirmary. Dickinson also commented upon the rarity of true bone formation in the kidney and mentioned its occurrence in association with cysts, pyonephrosis, and pyelitis.

Stoppato (1923) reported a case of partial hydronephrosis due to renal calculi with heteroplastic ossification of the walls of the hydronephrotic area in a 22-year-old male. Two calculi were found; the larger one was free but the smaller one was attached by osseous tissue to the walls of the localized hydronephrosis, the size of an orange in the upper pole of the kidney. A similar case was reported by Lozzi in 1923. It is extremely difficult to determine whether the osseous process in the walls of the hydronephrosis in these two cases is primary, *i.e.*, the result of metaplastic changes in the affected tissues or secondary to osseous changes associated with renal calculi, as described by Phemister, Hellstrom, and Stuart and Kirkorian. The authors are inclined to favor the latter view.

(*B*) *Renal Calculi.*—Osseous metaplasia of the renal pelvic epithelium associated with renal calculi is a rare pathological phenomenon. Phemister (1923) reported two such cases in which there were three stones, composed partly of living bone and attached to the renal pelvis in two cases and to a pyramid in one. The bone formation was of the spongy variety and contained marrow, fat, loose fibrous tissue, and capillaries in cancellous bone tissue. Similar cases were subsequently reported by Hellstrom (1931), Lozzi (1931), Stuart and Kirkorian (1932), and Huggins (1933).

The pathogenesis of the osseous metaplasia in these cases may be attributed to irritating and erosive action of the rough irregular stones upon the pelvic epithelium which is followed by an osseous metamorphosis in the connective tissue beneath the pelvic mucosa. The osseous metaplastic

changes are greatly enhanced by the presence of infection in the renal pelvis. The roentgenographic findings are not always sharply defined in these cases: the shadows of renal calculi usually stand out clearly but those of osseous tissue may be difficult to detect, due to the indistinct outline, the insufficient amount of calcium salts, or the masking by the kidney tissue of surrounding structures.

(*C*) *Renal Tumors: 1. Cysts and Perirenal Tumors.*—Bone formation has also been described in other diseases of the kidney and surrounding tissues. Phemister (1923) stated he has observed partial replacement by bone of calcified areas in renal tuberculosis. Kronlein and Wys have described a case of ossification of the walls of a cyst of the kidney in a woman 37 years old. The cyst was of the hemorrhagic type and contained blood clots and cholesterin crystals. Pick has reported the presence of osseous tissue in the calcified wall of a dermoid cyst. Campbell has pointed out that unusual shadows of bone or cartilage in the renal region may be present in the roentgenogram, and are suggestive of teratoma. In a case of pararenal teratoma in an infant, he observed similar roentgenographic shadows which, on gross and microscopic examination of the tumor, revealed cartilage but no bone.

Heincke (1909) reported a case of osteoplastic metastases in the retroperitoneal adipose tissue about the kidney from a primary sarcoma of the femur. The plain roentgenogram showed a large calcified shadow, about the size of a dollar, and several smaller shadows in the region of the left kidney. At autopsy, a flat hard platter formation of whitish-yellow tumor tissue of bony consistency was found in the region of the left kidney, and behind this there was another metastatic tumor, about the size of an apple and of bony consistency. In 1936, Weber reported an osteochondrosarcomatous tumor surrounding the left kidney and adrenal gland in a 15-year-old girl. The roentgenogram showed a calcified shadow in the kidney region. A similar tumor was found in the femur and was probably the primary growth.

2. Hypernephroma.—Ossification has also been reported in other types of kidney tumor. Albrecht (1905) reported a very interesting case of hypernephroma of the left kidney, with calcification and ossification, removed from a woman 58 years of age. Fabricius (1911) removed a cystic tumor of the kidney which contained nests of hypernephromatoma cells from a man 55 years old. The tumor had a dense, sclerotic, fibrous capsule in which calcification and bone tissue formation had occurred. Phemister (1923) stated that he had observed partial replacement by bone of calcified areas in a hypernephroma. In the same year, Baroni reported a case of hypernephroma with partial osseous metaplasia of the stroma, and cited similar reports by Pocharissky and by Gierke and Frankel in the literature. Federoff (1924) reported an interesting case of tumor of the lower half of a fused supernumerary right kidney, in a female 53 years of age, which showed calcification in the periphery and osseous tissue at the base and in central portions of the tumor.

Arkin (1926) reported a case of calcified and partly ossified hypernephroma of the left kidney, in a woman 46 years old, which is presumably the first case diagnosed roentgenographically during life. In 1921, a case of calcification and ossification of a hypernephroma (Case XIV) was observed by the authors, and a correct pre-operative diagnosis was made. This case is now reported for the first time. Moro (1933) described a case of ossification in a hypernephroma in a female 41 years of age. In each case, the osseous changes were noted in or about areas of necrosis, hemorrhage, or cystic dilatation. The presence of such changes within the kidney tumor may be the cause or result of an interference with the blood supply of the tumor, with the subsequent development of necrobiotic changes within the tumor, which provide a fertile soil for the deposit of calcium salts and an osseous metaplasia of the stroma elements. It is generally agreed that the osseous

changes are not due to metaplasia of the connective tissue of the kidney parenchyma adjacent to or invaded by the tumor.

Information concerning the roentgenographic findings in these cases is not available excepting in the cases reported by Arkin and Moro. The latter case showed a calcified shadow about the size of a goose egg which was interpreted as a calcified cyst. In the absence of roentgenographic details in the remaining cases, it is difficult to predict the type of shadow by the osseous tissues within the tumor, but obviously the intensity of shadow varies according to the degree of osseous metaplasia and the size of the tumor.

3. Mixed Tumors.—Bone formation in the human kidney is more commonly associated with mixed tumors (embryoma or teratoma) than with any other type of renal lesion. These mixed tumors are not strictly limited to infants and children but may occur in adults.

Hedren (1907) reported the first case of extensive bone formation in a mixed tumor in a female 54 years old. Lomon (1913) reported a case of osteoma of the kidney (confirmed by operation) in which a diagnosis of kidney tumor was made from the roentgenographic findings, *i.e.*, enlarged kidney outline, situated low, and spotted with small dense shadows. Thiede (1913) described a case of osteochondro-fibroma of the kidney capsule. Pirondini (1917) described a case of osteoblastoma in a 37-year-old male. Hildebrand observed a fibro-myo-osteosarcoma, weighing two kilograms, in a female 30 years old. Desnos (1923) reported two cases of osteofibroma of the kidney in males 48 and 35 years old, respectively, and cited similar cases by Marion and Brugnatelli. Ssoroka (1931) observed mixed tumors in two adults, 38 and 58 years, respectively, in one of which osseous tissue was noted. Haining and Poole (1936) described a case of osteoblastoma of the left kidney, with osseous metastasis to the other kidney, and in a male 76 years old.

(D) Vascular Lesions of the Kidney: 1. Endothelioma.—This type of ossification is extremely rare, as only two cases could be found in the literature. Ponzio (1913) reported an unusual case in which an ovoid shadow about the size of a hazel nut was found on the renal region in the plain roentgenogram, and diagnosed as a renal calculus. At operation, no trace of a calculus was found but, following nephrectomy, a firm, smooth, ovoid body, the size of a nut, was found in the renal bed and was extirpated. It was made up of calcareous and bony portions and contained a soft bloody coagulum. Histological examination of the wall of the osseous formation disclosed the characteristic structure of a vein, with preservation of the endothelium, muscular coat, and adventitia. The author considered the growth to be an endothelioma but was unable to state whether the vein belonged to the renal cavity proper or to some retroperitoneal tissue.

2. Infarct.—Schmorl (1930) reported an unusual case of ossification of the kidney, associated with complete interference with blood supply to the kidney. The patient had developed a complete infarction of the blood supply of the kidney, with subsequent formation of bone beneath the mucosa of the renal pelvis. This type of calcification is analogous to that obtained by Sacerdotti and Frattin following permanent ligation of the renal pedicle; this case is the only one of its kind found in the literature.

CONCLUSIONS

A review of the literature and a study of personal cases of calcification of the kidney, associated with various renal diseases, warrant the following conclusions:

1. Calcification of the kidney is an infrequent, though not uncommon, pathological finding.

2. Calcification of the kidney may occur in two forms: (*a*) metastatic and (*b*) non-metastatic. The non-metastatic group may be further subdivided into the two following types: (*a*) calcification associated with acute or chronic inflammatory diseases of the kidney—*kalkgicht;* (*b*) dys-

trophic calcification associated with chronic degenerative lesions of the kidney.

3. Metastatic calcification of the kidney ("*Kalkmetastasen*" of Virchow) occurs in various destructive bone diseases, *i.e.*, osteitis fibrosa cystica, osteomalacia, osteopsathyrosis, osteosclerosis, myeloma, etc., which are accompanied by a hypercalcemia. The essential factor in this type of calcification is the increase in the calcium content of the blood due to absorption of calcium salts from the bone lesions. The vast majority of these cases develop in the absence of a renal lesion.

4. The non-metastatic type of calcification ("*Kalkgicht*" of Schmidt) is associated with an acute or chronic inflammatory disease of the kidney. The renal lesion may be primary (chronic nephritis or arteriosclerosis), or secondary (toxic degenerative nephrosis). This type of calcification was observed in individuals with a normal blood calcium, although the degree of calcification is more marked when associated with a transitory or permanent hypercalcemia. The essential factor in this type of calcification is a calcium retention resulting from an impaired renal function caused by a nephritis, usually of the chronic type. The excessive excretion of albumin by the damaged kidney produces a disturbance of buffer properties of the blood, albumin, and phosphates, and decrease in the solubility of the calcium salts of the blood, conducive to the precipitation of these salts in the damaged kidney.

5. The dystrophic type of non-metastatic calcification is associated with a chronic destructive or degenerative lesion of the kidney, *i.e.*, pyonephrosis, abscess, tuberculosis, neoplasm, etc. This type of calcification is directly dependent upon local retrogressive changes, *i.e.*, faulty infiltration, hyalinization, necrosis, etc. The degree of calcification is influenced to some extent by degree of vascularity, the phosphatase activity of the tissue, and the amount of calcium in the blood and tissues.

6. Many of the areas of calcification of the metastatic and dystrophic types are readily discernible in the roentgenogram. The former variety are usually seen as radiable streaks or patches in the pyramids in close proximity to the calices, whereas in the latter variety the calcified areas are irregular and scattered throughout the renal parenchyma.

7. In our experience, calcification in a renal neoplasm may be considered a favorable sign.

8. Ossification of the kidney is a rare pathological finding and is usually associated with destructive or neoplastic diseases of the kidney. The formation of bone in the kidney is the result of osseous metaplastic changes in the connective tissue beneath the pelvic epithelium in the case of renal calculi, or in the stroma of the affected areas in the case of tumors, cysts, pyonephrosis, etc.

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THE ROENTGEN TREATMENT OF CHRONIC SINUSITIS[1]

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IN the long history of infection of the nasal accessory sinuses, the final chapter has not yet been written. Although it is one of the oldest of medical problems, little was accomplished in the way of treatment prior to fifty years ago. To our predecessors it presented a baffling problem and little was done beyond diagnosing the condition as catarrh and abandoning the victim to be preyed upon by the patent medicine vendor. With the development of rhinology the challenge became more sincerely accepted and during the past thirty or forty years much constructive work has been accomplished. In more recent years a vast amount of careful scientific study has been carried out which has resulted in a more accurate understanding of the varied underlying causes and the treatment.

Well trained observers have probed deeply into the anatomy, physiology, histology, and pathology of sinus disease, and skilled surgeons have devised technical procedures for the relief of its sufferers. Despite all of these efforts there still remain too many sufferers who fail to respond to any or all of the available methods of treatment. That the problem is a complex one is recognized by all who have occasion to treat this disease. Factors underlying its pathology are many and varied, and because of this fact the treatment also must be varied according to the cause. It is not the purpose of this paper to discuss all of the methods employed: it is sufficient for this discussion to direct our attention to those patients suffering from chronic infection of the nasal accessory sinuses who have failed to gain relief from other conservative methods of treatment and who, therefore, face the possibility of so-called radical surgery. We do not disapprove of radical surgery when performed upon patients who have exhausted the more conservative procedures without relief, providing the surgeon who performs the task is well skilled in this technically difficult operation. Unfortunately this has not always been the case, and the failures have been so widely advertised that the patients and their physicians have become rather reluctant to face the ordeal. The pendulum has now swung back to a more conservative position and a renewed effort to find less formidable methods has been the result.

During the past seven years we have observed the effects of the roentgen ray as a therapeutic agent in chronic sinus disease, and during this time we have studied the results on experimental animals as well as the clinical observation of well over two thousand treatments. With this experience as a basis, we believe that we are justified in pleading for a more general use of this valuable aid in those cases adapted to it.

That the roentgen ray is an agency that should be expected to be effective has been proved in other fields. Dunham (1), Desjardins (2), Kelly (3), Hodges (4), and many others in America and abroad have published works supporting this statement. In 1923, Osmond (5), of Cleveland, reported a series of cases of acute sinusitis treated by roentgen ray with good results.

The mucosa of the sinuses is thinner and much less vascular than that of the nose and, therefore, is less resistant to infection. It is provided with numerous cilia which serve to waft toward the ostium a web of mucin which is constantly being secreted by the many goblet cells. During the course of an infection there is an engorgement of the mucosa due to increased blood and lymph supply. The inroads of infection gradually immobilize the cilia and

[1] Read before the Fifth International Congress of Radiology, Chicago, Sept. 13–17, 1937.

eventually destroy large areas of the surface epithelium. During this period there is an influx of histiocytes and polymorphonuclear cells (7). There is a gradual breaking down of the lymphocytes, and the histiocytes set about to effect fibrous repair or to develop into macrophages engulfing bacteria and cellular débris.

The engorgement of the mucosa interferes with proper function of the cilia, and eventually stasis is brought about; later, large surfaces containing cilia are destroyed and slough out. When the infection becomes chronic the entire cavity frequently becomes filled with engorged membrane, or at least the swelling is sufficient to close the ostium and to prevent drainage.

Bacteria are found in large numbers deeply buried in the tissues as well as along the surfaces, a fact which alone shows the futility of topical applications or the instillation of antiseptic solutions into the sinus cavities. Some means must be employed to stimulate the normal activities of the histiocytes and macrophages toward destruction of the bacteria, and repair.

In 1934 the authors published briefly their findings on a series of experimental animals (6). The frontal sinuses of the cat have been found to correspond very accurately with those of the human. Fenton and Larsell (7) have devised a very successful technic by means of which they can be infected and the infection maintained until changes comparable to those of chronic sinus disease in the human can be developed. Under the direction of Dr. Larsell, head of the Department of Anatomy of the University of Oregon Medical School, a number of cats were thus infected, and when the infection became "chronic," half of the animals were irradiated and then autopsied at varying intervals, each with its control. The membranes were then carefully prepared and studied by him, and the findings were practically identical with those of other observers who had worked with irradiated tissues from infected areas elsewhere in the body.

The cat membranes examined following exposure to the roentgen ray showed early destruction of the lymphocytes. The macrophages were also found earlier and in greater numbers than in the untreated controls which had been similarly infected. In no case was there evidence of injury to any of the normal cellular elements as the result of irradiation, though one group had been given twice the amount of irradiation used in the treatment of patients. Normal ciliated membrane was found in those cases in which healing had taken place.

The above described changes explain the rationale of roentgen therapy in these cases. The early influx and destruction of lymphocytes with the liberation of the antitoxic substances that they are thought to contain, together with the early appearance of macrophages in greater numbers, intensify the usual reaction to the infection and hasten repair. This explains the reaction that occurs several days following treatment. The patients usually notice an increase in nasal discharge and other sinus symptoms, beginning a few days after treatment and lasting for three or four more days.

We do not hold that roentgen therapy is applicable to any and all types of sinusitis. We are well aware that a good percentage of acute cases frequently clear up spontaneously or yield readily to conservative methods. We realize that certain factors are capable of producing sinus reactions and these must be treated by appropriate measures. It goes without saying that a syphilitic involvement requires proper antisyphilitic therapy and should not have irradiation.

Our efforts to relieve atrophic sinusitis have not met with success; likewise, we have seen no benefit from x-ray irradiation of cysts or polypi. Several of our patients have been irradiated following the removal of polypi in an effort to prevent recurrence; so far, the treatment has been successful in that respect.

The presence of a cyst, co-existent with hypertrophic membrane and other sinus symptoms, does not retard resolution of the other pathologic conditions following

irradiation. We have had several such cases wherein the symptoms subsided and the membranes underwent resolution, leaving the cyst unchanged.

Our greatest number of failures have been met with in those patients who have failed to gain relief following radical surgery. Here we are faced with large masses of scar tissue upon which the roentgen ray cannot be expected to be effective. Occasionally, however, we are pleasantly surprised with an excellent result. One such case was that of a rhinologist in a nearby city who had himself suffered from sinus trouble for many years. He presented himself for treatment with the history of having had a radical surgical attack upon all of his sinuses. The efforts had not been successful and he was in constant distress. Radiographs revealed a marked fibrosis of all sinuses. We explained the probability of failure; but since he had come so far, and knowing that we would do no harm, the treatment was given. Fortunately the result was good and he found himself greatly improved. Recently he has published a report covering a series of his own cases for whom he recommended roentgen therapy (8).

When the radiographs show an opaque sinus with considerable fibrosis the results have been variable; it would appear that little change can be expected from sinuses in this condition. However, some of these patients return free of symptoms, the radiographs showing a normal appearing antrum; others may report clinical improvement of varying degrees, while still others may be outright failures.

It not infrequently happens that the patient gains a marked clinical improvement without a complete disappearance of sinus symptoms. If the infection has been of a virulent nature with much fibrous repair, the sinuses may not show much, if any, radiographic improvement. Many of these patients continue to have postnasal discharge, but the character of the drainage has changed from one that is laden with pus to one of a clear, thin, gelatinous nature.

We have obtained our best results with those patients who have had symptoms of chronic infection extending over a period of months or years, and whose radiographs show a markedly thickened membrane with a small air-containing cavity in the center. These patients usually respond to a single treatment. Patients in this group usually return in six or eight weeks with clear sinuses, no discharge, and complete absence of secondary symptoms.

The effect upon secondary symptoms throughout our series has been interesting and gratifying. Headaches, neuritis, bronchitis, and similar manifestations which have been traced to infected sinuses, have in almost every instance cleared up, even though the patient has failed to show a complete resolution of his sinus pathology after irradiation.

Throughout this series the reactions have been negligible. The average patient will notice an increased nasal discharge, beginning several days after the treatment and persisting for three or four days. There may be a mild malaise simulating an acute sinus flare-up. Occasionally drainage may be blocked, necessitating antrum washing, although this has been rare in our experience. A few patients have developed an early erythema—within an hour or so—which cleared up within 24 to 36 hours. A few patients have developed a true x-ray erythema, but all have cleared up in a short time. There has been no case requiring hospitalization or other loss of time. In no instance has there been any harmful result. A few of our patients, failing to obtain relief from roentgen therapy, have submitted to radical surgery. The surgeons have reported to us that they have encountered no difficulty in removing these membranes.

The technic of treatment as used in our office for the past seven years is as follows: First, the eyes and nose are carefully protected by lead shields. For the maxillary sinuses we use a port 1.25 in. in diameter. The central ray is directed posteriorly, medially, and slightly superiorly, so there

will be a cross-firing of the ethmoids and sphenoids.

For the ethmoids we use lead foil applied so that only the ethmoids on that particular side are unprotected. The central ray is again directed obliquely posterior, again cross-firing the sphenoids. The frontals are treated through lead foil with appropriate opening.

Each area is treated separately with due care not to overlap the skin previously exposed. All areas involved are treated the same day. We have found that better results have been obtained from the maxillary treatments when the ethmoids are also treated, if they show the least suspicion of infection. The factors we use are 120 kv.p., 5 ma., 4 mm. aluminum filter, 11-inch distance for 10 minutes through each port. This amount of irradiation is equivalent to 700 r with back-scattering.

The patient is asked to report back in six or eight weeks, at which time a recheck is made. Of those persons who have obtained good results, we have found that the greater percentage required only the one treatment. If the sinuses have not entirely cleared up, but the patient has improved, further treatment may be given using due caution not to overtreat the skin.

During the past 18 months we have treated a series of cases using higher voltage and filtration (200 kv.p., 20 ma., 0.75 mm. copper, and 3 mm. aluminum filter, 55 cm. distance for 10 minutes through each of two ports). With this technic we shield one side of the face with lead except over the maxillary, ethmoid, and frontal sinuses on that side. The central ray is directed obliquely posterior, to cross-fire the deeper cells. The procedure is repeated from the opposite side at the same sitting. This dose is the equivalent of 530 r measured with back-scattering (450 r measured in air).

We have found that this technic gives results equal to the 120 kv.p. dose and has the added advantage of greater penetration and much greater protection to the skin, so that further treatment may be given with a wider latitude of safety.

Both of the technics mentioned above apply only to adult patients with chronic sinus disease. When dealing with acute involvement or in treating children, the dose may be materially reduced.

There can be no guarantee against recurrence, but we have noticed that seldom is there a return of symptoms as severe as the original. Many of these patients have been able to withstand severe upper respiratory infection without a return of their sinus symptoms. Our first patient, treated several years ago, is employed by us, and we have watched her progress with interest. Thus far she has been able to throw off nose colds without again acquiring her old sinus involvement. We have treated many children by this method and the results have been uniformly good.[2] No effect on normal dentition has been observed.

From our experience with roentgen therapy in chronic sinusitis we are firmly convinced that it has a very definite place in the treatment of this widespread disease. In the hands of a skilled roentgenologist it is capable of accomplishing much good and is not harmful. It is worthy of wider consideration by rhinologists and radiologists than has heretofore been accorded it.

CONCLUSIONS

1. Seven years of experience in the use of the roentgen ray in the treatment of chronic sinusitis has convinced us that it has a definite therapeutic value in properly selected cases.

2. When skillfully applied it does no harm and causes no serious reactions, and there is no loss of time for the patient.

3. Failure of roentgen therapy in no way interferes with subsequent surgery should the latter become desirable.

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[2] Since this paper was written, an interesting article, "Roentgen Therapy of Chronic Sinusitis in Children," has been published by Rathbone (Am. Jour. Roentgenol. and Rad. Ther., July, 1937).

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PAIN: ITS SURGICAL RELIEF AND THE RÔLE OF X-RAY LOCALIZATION THEREIN

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ALTHOUGH pain as a syndrome may be said to have existed since the world began, in contrast to other sensations it can be defined as a sensation of exception, or scientifically speaking, one of pathology. It is true that the pain syndrome possesses certain educational properties and appears as such especially in childhood and infancy when the movements and the life of adaptation begin. Notwithstanding this fact, however, pain in itself does not enter into the realm of those functions which are said to be absolutely necessary for normal life. We all know that normal adult life may be free from pain for a long period of time; this in itself can serve as an argument for the necessity of the existence of such sensation as pain. In some instances unquestionably the duty of pain is to signal to our conscience the existence of some stimulus which is damaging to the organism, and its purpose is to induce, even before conscious sensation, those immediate defensive reflex mechanisms which are at the disposal of the living tissues.

As a result of much research and various investigations, among which the work of Lugaro is outstanding, the following conclusions can be drawn: Pain in a strict sense is produced by stimuli which threaten the integrity of the tissues, and although to certain forms of pain we can assign a useful defensive function, often pain is an excessive reaction, paraphysiological, useless and damaging, provoked by destructive stimuli to which the organism cannot produce adequate protective response.

Combating such types of useless and damaging pain has been the aim of physicians and surgeons since time immemorial, but it has been only since the most modern methods of neuro-surgery were developed that true progress has been made in this respect.

We will not discuss here the technical aspects of various surgical procedures, but we wish to point out that on numerous occasions failure of success in various neuro-surgical methods related to the relief of pain has been due to lack of proper localization, both from diagnostic and therapeutic points of view. It was not until the co-operation of physiologists and roentgenologists was invited that several of the neuro-surgical procedures were lifted from the realm of art into the rank of precision and a scientific technic.

For the purpose of surgical relief of the pain syndrome, to be done irrespective of the underlying pathology, the present-day neuro-surgeon has at his disposal the most variegated procedures, among the more selective of which we will find the therapeutic nerve block. By basing our knowledge upon research and analytical data related to physiopathology of pain, we know that in order to surgically relieve the pain syndrome it is necessary to interrupt the conductivity in a sufficient number of peripheral or visceral nerve fibers supplying the given area to produce in this fashion the lack of excitability of sufficient strength so as to arrest the passage of an excessive number of impulses. Such an excessive number of impulses, when summated, are transmitted and received by the central nervous system in the form of pain.

The interruption of the conductivity in the nerve trunk by means of resection has several disadvantages: (1) The surgical procedure requiring an exposure of the nerve trunk is far from being simple. (2) In case of mixed trunks (composed of motor and sensory fibers) the separation of sensory fibers is never accurate and a great amount of motor fibers is also permanently destroyed, producing at its best more or less permanent motor weakness of the area

innervated by the given trunk. (3) The number of nerve trunks, ganglia or plexuses such as are amenable to the resection technic is limited due to anatomical factors as compared with the number of trunks which may be involved in each given case in various types of neuralgias and painful syndromes. In such cases the advantage of nerve blocking over surgical resection is most evident, not only because there is no necessity to traumatize large and deep areas of tissues, but also because the modern neurolytic solution is particularly adapted for the temporary destruction of the sensory nerve fibers.

The chief difficulties connected with the nerve blocking procedures up to recent times could be divided into three parts: (1) Lack of technical means of definitely localizing the area of pain and tracing the nerve fibers, trunks, and plexuses through which painful impulses are being transmitted into the central nervous system. (2) Choosing a definite point along the nerve trunk, etc., at which point it is best to interrupt the conductivity and so arrest the passage of painful impulses. (3) To block the respectively affected nerves quickly and with a minimum of trauma to the surrounding tissue as well as without necessity and danger of puncturing the nerve trunks with the blocking needles, which condition may occur if the surgeon is depending upon the "mental picture of the underlying skeleton" and his sense of touch.

The above, in addition to the fact that we must have exact data as to the precise location and depth of the respective nerve trunk, rendered the nerve blocking a very difficult technical procedure, available only to a few expert specialists who mastered the complicated and artful technic of locating the nerve trunks by means of empirically established landmarks, depending only upon such variegated guides as their own personal tactile sense for the accuracy of the procedure.

At the beginning, the injections for "sciatic neuralgias" were made in the gluteal regions, but it was found that the depositing of rather large quantities of alcohol, its mixtures or derivatives, in the middle of muscular layers which surround the nerve at that level, produces secondary myositis and, in certain cases, constriction sclerosis. The painful syndromes which were arrested at the beginning, several months later (after the nerve trunk was fully regenerated from the alcohol fixation) reappeared, due to the new stimuli of painful nature which arose, being initiated by the hardened fibrous sclerotic muscular tissue, which developed following alcohol injection; such reappearing painful syndrome in many instances showed symptoms of even greater severity than the original neuralgia.

Means were then sought to limit the amount of anesthetic solution necessary for the interruption of nerve conductivity, and it was found that the only reliable way of doing so was to deposit those small amounts of solutions in close vicinity to the nerve at the point at which the same emerges from the respective spinal foramen, whether it be first or second transacral foramen or lateral vertebral foramen in cervical, dorsal, or lumbar region (Fig. 1).

The same was true in other locations when the surgeon was obliged to depend upon relatively large amounts of neurolytic solution and its diffusion for the success of the respective technic. On numerous occasions in such instances the unfavorable sequelæ followed the nerve blocking procedure and could be traced to various forms of perineural sclerosis which developed following the destructive action of too strong neurolytic solution which was injected in quantities much too large.

Paravertebral or prevertebral nerve block, when performed by fractional technic, is a selective method of precision. To perform such nerve block a minimal amount of solution should be employed. In order to accomplish this it is necessary for the neuro-surgeon not only to be familiar with the relations that the respective nerve trunks bear to the deep bony landmarks which he is to utilize during the

nerve blocking technic, but he must also know the exact location and depth of such bony landmarks as well as be able to localize

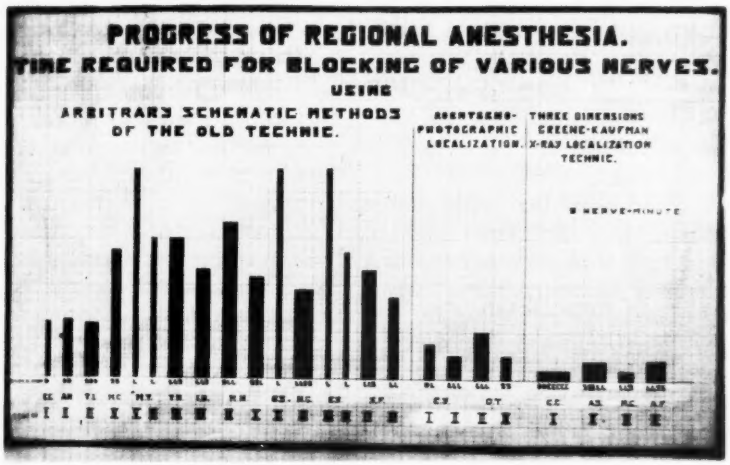

PROGRESS OF REGIONAL ANESTHESIA.
TIME REQUIRED FOR BLOCKING OF VARIOUS NERVES.
USING
ARBITRARY SCHEMATIC METHODS OF THE OLD TECHNIC.
ROENTGENO-PHOTOGRAPHIC LOCALIZATION.
THREE DIMENSIONS GREENE-KAUFMAN X-RAY LOCALIZATION TECHNIC.
1 NERVE-MINUTE

Fig. 1. Represents a graphic chart showing the relative times required for blocking according to the old "artful" method, and the modern scientific method of x-ray localization. Each column represents a case. The height represents the mean average per nerve. The width of each column represents the number of nerves blocked per case. The letter refers to the region block: (1) L, lumbar; (2) S, sacral; (3) D, dorsal, and (4) C, cervical. In certain cases the time required for blocking has been reduced by x-ray localization method from 30 minutes to two minutes.

such bony landmarks in their relation to the surface of the skin. Intraneural injections should be prevented as they are dangerous and will serve no purpose. Up to recent years the surgeon performing the blocking could depend only upon his sense of touch and empirically established localization of deep bony landmarks for the accuracy of his technic. Due to anatomical variations each case presented a separate problem. (See Figs. 9-*A* and 9-*B*.)

Taking into consideration what we have said before, we can readily note the necessity for exact knowledge as to the location of bony landmarks and the associated nerve structures in connection with any type of surgery, but when it concerns neuro-surgery, especially in respect to the pain syndrome, such precise knowledge is imperative and indispensable for success. In numerous instances, especially in more or less chronic conditions associated with such pathologic changes as diseased spine, joints, bones, nerves, or chronically inflamed tissues, routine forms of treatment failed to produce the recovery, not because the treatment was improper, but because the associated pain syndrome was not attended to properly and its continuous existence did not permit the patient to derive even the slightest benefit from the instituted treatment.

Modern neuro-surgery created new and improved methods for the treatment of such conditions. We will take as an example the patient who has been suffering from severe pain associated with chronic bursitis of the shoulder, a common occurrence following wrenching of the extremity. Unless the treatment is primarily directed toward relief of pain and secondarily toward joint and muscle rehabilitation, it will be met with failure. Any attempt at massage, passive or active motion, or even physiotherapy will be met with objection on the part of the patient unless the pain syndrome has been previously controlled. Relieve the pain and you will gain the confidence and co-operation of your pa-

tient. Once this is done the routine therapeutic measures will speedily bring about the long-desired recovery.

In the instance just cited a properly administered chemico-surgical neurolysis or nerve block will fully control the pain syndrome. The fractional method of paravertebral nerve block neurolysis which can be successfully employed in rehabilitation of various injuries, such as, for example, strains in the lumbar and other regions, secondary post-traumatic neuronitis, so-called sciatic neuralgia, various forms of causalgic pain syndromes, and those painful conditions so often associated with peripheral paralysis, depends for its success upon proper localization and visualization.

In instances in which it is desirable to resort to such procedures as precision laminectomy or chordotomy, exact knowledge of the location of the respective bony structures which serve as landmarks and beacons to the neurological surgeon is indisputable. A great deal of unnecessary surgical traumatism can be eliminated by resorting to x-rays for localization purposes.

In carrying out such type of advanced procedure as section of lateral lemniscus at the brain stem, which was promulgated by Dogliotti and which in many instances is the only means at our disposal for relieving the patient of the excruciating and otherwise uncontrollable pain, we must also possess specific knowledge of the localization of various structures involved. Undoubtedly this visualization is most important when we are dealing with the treatment and rehabilitation of the industrial worker in whom the syndrome of pain has been the outstanding clinical factor. Many such patients are permitted to become chronically disabled, thus becoming a burden to the family and community, notwithstanding the fact that a vast majority of patients of this type can be relieved of their pain and return to their daily occupation if they are only carefully diagnosed neurologically and submitted to the proper form of regional therapeutic anesthesia. We feel certain that when a greater number of physicians recognize the necessity for more precise visualization in connection with various surgical procedures in general, and in connection with neuro-surgery as related to the pain syndrome in particular, then the various methods of surgical relief of pain will become more accurate, more successful, and safer and, therefore, more popularized, thereby sparing the patient months and years of useless pain and agony.

The use of x-ray for localization purposes has been aimed at since the introduction of radiography. Various methods were devised such as stereoscopy, teleroentgenographic localization, orthodiography, radiographic compass localization, etc., none of these methods being sufficiently simple technically and sufficiently accurate mathematically to be applicable for localization in connection with the surgical treatment of the syndrome of pain.

In 1923, George Friedrich Kunz, José de Carvajol-Forrero, and Marius B. Greene began with research which culminated with the development of x-ray localization technic and measurements to be used for the purpose of localization and identification in crystallography.

In 1930, one of us (M. B. G.) developed a new roentgeno-photographic method of localization to be employed in therapeutic nerve block. In this way he was able to reduce the time consumed for accurate lumbar therapeutic nerve block from 15 minutes to three. His method was only an approximation to actual mathematical precision; furthermore, it did not define depth.

In 1932, following independent research by one of us (J. K.), who has been interested in x-ray localization since the time of the World War (1919), both of us developed a mathematically precise graphic method of x-ray localization. Two localization charts were prepared to facilitate the actual surgical procedure of nerve block: (1) the Vertical Projection Chart; (2) the Depth Chart.

The Vertical Projection Chart defined

and designated anatomical structures in relation to previously tattooed skin points. The Depth Chart defined the depth of these structures beneath the skin surface.

In 1936, one of us (J. K.) published "Standard Depth Curves," to be employed in localization procedures. Since then, the Depth Chart has been prepared in conjunction with these curves.

The advantages of localization charts for nerve block can be readily appreciated by consulting Figure 1, which is a graphic record showing the time consumed in three different surgical procedures of nerve block: (1) the Old Empiric Method; (2) the Roentgeno-photographic Method; (3) the X-ray Localization Method.

For simplicity's sake, this section has been divided into the following parts: I. Anatomical structures designated by the anesthetist-surgeon; II. application of the skin points; III. preparation of the x-ray films; IV. preparation of the x-ray table; V. x-ray procedure; VI. analysis and marking of the x-ray films; VII. transcription of the x-ray data; VIII. analysis of the transcribed data; IX. vertical projection chart; X. depth chart; XI. application of the localization chart; XII. derivation of the "Standard Depth Curves."

I. The Anatomical Structures Designated by the Anesthetist-surgeon.—Before the patient is to be "blocked," it is the duty of the anesthetist-neuro-surgeon to assemble and take into account all the necessary data regarding the particular case in question. He knows, too, which anatomical structures he will use as guides to facilitate the actual surgical procedure and designates them to the x-ray consultant as the ones to be localized. If, for example, the case is one requiring lumbo-sacral block, he will designate the transverse processes of the first, second, and third lumbar vertebræ, and the posterior first and second sacral foramina, five in all. These are the structures which will be of vital importance to him under the circumstances.

For any other blocking or surgical procedure, diagnostical charts or mensuration, he will designate other anatomical structures. In other words, in any individual case, the anesthetist-neuro-surgeon designates those structures for localization which suit his purpose. After all, he is in a better position to know which structures he will employ to guide him than the roentgenologist, whose sole purpose is to prepare the localization charts from appropriate x-ray films.

II. Application of the Skin Points.—Points are tattooed on the patient's skin: (1) to facilitate the localization of the designated anatomical structures, and (2) to act as guides for the application of the localization charts when the blocking is actually undertaken. In deciding where to place these skin points, we have found it expedient to adopt the following rules for guidance: (1) place a skin point as nearly as possible directly over each of the designated anatomical structures; (2) place a skin point above the level of these structures; (3) place a skin point below the level of these structures, and (4) place a skin point in any spot where there is an abrupt change of contour, or of direction.

In lumbo-sacral cases, we ordinarily use eight skin points: one is placed directly over each of the five designated anatomical structures. A sixth is placed above the level of the first lumbar transverse process. A seventh is placed below the level of the second posterior sacral foramen. The eighth is placed in the hollow of the back where there is an abrupt change of contour from back to buttock. Each of the skin points is designated by a number. In the lumbo-sacral cases, the uppermost is No. 1, the lowermost No. 8, the intermediate Nos. 2, 3, 4, 5, 6, 7 in succession. A small lead marker is strapped over each of the skin points so that the images of these points will be visible on the films when the x-ray exposures are made.

III. Preparation of the X-ray Films.—After the lead markers have been strapped to the skin points, two 14 × 17 in. screened films are prepared as follows: (1) To the first a lead numeral *1* is strapped along its upper border. This is called Film 1; (2)

to the second the lead numeral *2* is strapped along its lower border. This is called Film 2.

IV. The Preparation of the X-ray Table.—Prior to making the necessary x-ray exposures, the x-ray table is prepared as follows: (1) The target-film distance is always set at 32 inches, corresponding to one of the two standard factors (Fig. 5) employed in the derivation of the "Standard Depth Curves" (target-film distance equals 32 inches). (2) The target is centered over the central longitudinal axis of the table. This position of the target is called "T.1" (Target 1). (3) A plumb line is dropped from T.1 to the table top, denoting the vertical projection of T.1. For abbreviation we will call this point "V.T.1" (vertical projection of T.1). A small lead marker is strapped to the table top to correspond to this point. (4) The target is shifted exactly nine inches along the longitudinal axis of the table. This corresponds to the second standard factor (Figs. 5 and 7) employed in the derivation of the "standard depth curves" (target-shift equals nine inches). The second position of the target is called "T.2." (see Fig. 7). (5) A plumb line is dropped from T.2 to the table top, defining the vertical projection of the T.2. This point is labelled "V.T.2." A second lead marker is strapped to the table top corresponding to V.T.2.

In our method it is necessary to make two x-ray exposures, the target always first being put in the T.1 position. Film 1 is always used for this first exposure. When Film 1 is developed the image of V.T.1 will be readily identified as the true vertical projection of T.1. The image of V.T.2 will be visible also, but will represent a distorted image. This follows from the manner in which the table was prepared (see above). Likewise, when Film 2 is exposed from the T.2 position the image of V.T.2 will be identified readily as the true projection of V.T.2, whereas the image of V.T.1 will now be distorted.

V. The X-ray Procedure.—The two x-ray exposures are made in the following manner: (1) The target is placed in the T.1 position. (2) Film 1 is placed in the Bucky diaphragm. (3) The patient is placed upon the table so that the series of lead markers strapped to the skin points are about five inches lateral to the longitudinal axis of the table. This position is maintained for the two exposures required. (4) An exposure of Film 1 is now made from the T.1 position. (5) The target is moved to the T.2 position. (6) Film 2 is exposed from this position. (7) Both films are processed in the routine manner.

VI. The Analysis and Marking of the X-ray Films.—Each film (see Fig. 2 for schematic representation of Film 1) has depicted on it the following: (1) The image of lead numeral No. 1 along the upper margin of Film 1. (2) The image of lead numeral No. 2 along the lower margin of Film 2. (3) The image of V.T.1 (*A* in Fig. 2), representing the true vertical projection of T.1 on Film 1, is therefore labelled V.T.1 on this film. (4) The image of V.T.2 (*B* in Fig. 2), representing the true vertical projection of T.2 on Film 2, is therefore so labelled on Film 2. (5) The images of the eight lead markers strapped to each of the tattooed skin points. On Film 1 these are marked by ink spots and designated Sk.1 T.1, Sk.2 T.1, etc. On Film 2 they are similarly marked and designated Sk.1. T.2, Sk.2. T.2, etc. (6) The images of the five designated anatomical structures. On Film 1, they are marked by crosses and designated Tr.1 T.1, Tr.2 T.1, Tr.3 T.1, Sa.1. T.1, Sa.2. T.1. On Film 2 they are marked as before and designated Tr.1. T.2., Tr.2. T.2, etc. (7) On Film 1, V.T.2 is marked by making V.T.1—V.T.2 (see Fig. 2) equal to 9 in. (the distance of the target shift). (8) On Film 2, V.T.1 is marked by making V.T.2—V.T.1 equal to 9 inches.

VII. The Transcription of the X-ray Data.—After these points have been marked on the x-ray films, they are transcribed to a transparent sheet of paper. (1) The points are first transcribed from Film 1 (Fig. 3) by superimposing the transparent sheet of paper directly over

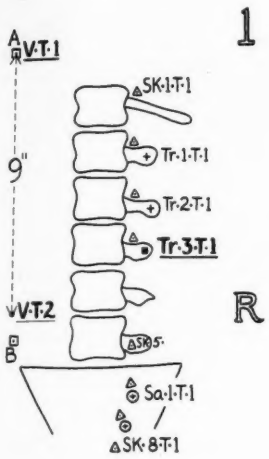
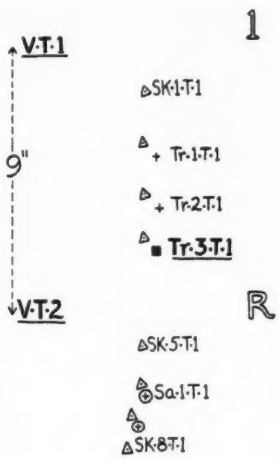


Fig. 2.



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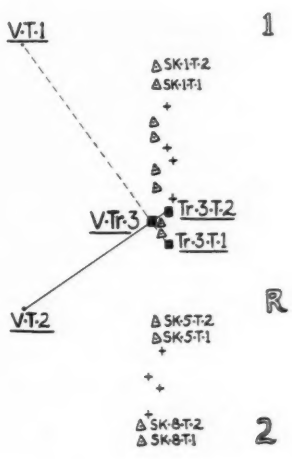

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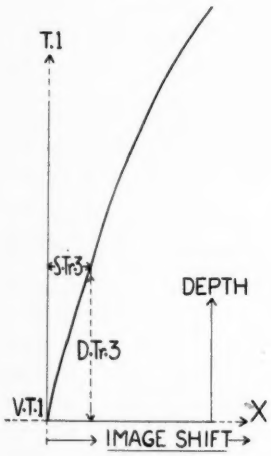


Fig. 5.

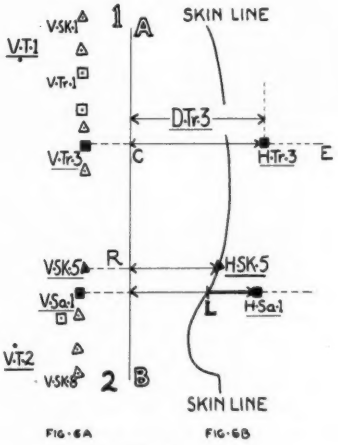


Fig. 6.

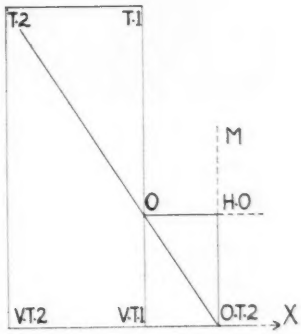


Fig. 7.

the illuminated film. (2) Film 2 is then substituted (Fig. 4), and the same transparent sheet superimposed over it so that the points V.T.1 and V.T.2 on the sheet correspond to the points V.T.1 and V.T.2 on the film. The other points are then transcribed.

VIII. Analysis of the Transcribed Data.—On the transcribed transparent sheet (Fig. 4) we note that there are present: (1) points V.T.1 and V.T.2; (2) two ink spots for each of the eight skin points; (3) two crosses for each of the five designated anatomical structures.

One can readily see that the distance separating each set of points varies from that separating any other set. Thus the distance Tr.3. T1—Tr.3. T.2 is much greater than Sk.5.T.1.—Sk.5.T.2. The distance separating each set of points we call the "image shift." The distance separating any individual set of points is denoted by the symbol *S*, followed by the symbol for that point. Thus, the image shift of the third transverse process would be designated "S.Tr.3." The image shift, *S*, for any point is employed in conjunction with the "standard depth curves" to define the depth of that point above the plate level (Fig. 5). By applying S.Tr.3 along

Fig. 8. Roentgenogram taken during the process of nerve blocking. The localizing needles are in their respective positions resting against the dorsal surface of the transverse processes. At the lower right-angle, blocking needle B is found in the exact position below the lower border of the transverse process in the vicinity of the point of exit of the fourth lumbar nerve trunk: 0.25 c.c. of neurolytic solution must be deposited at this location for a successful therapeutic block. Only through means of x-ray localization can such accuracy of technic be secured.

the horizontal axis V.T.1—X, the depth of the transverse process above the plane of the plate, D.Tr.3, may be read along the vertical axis V.T.1—T.1.

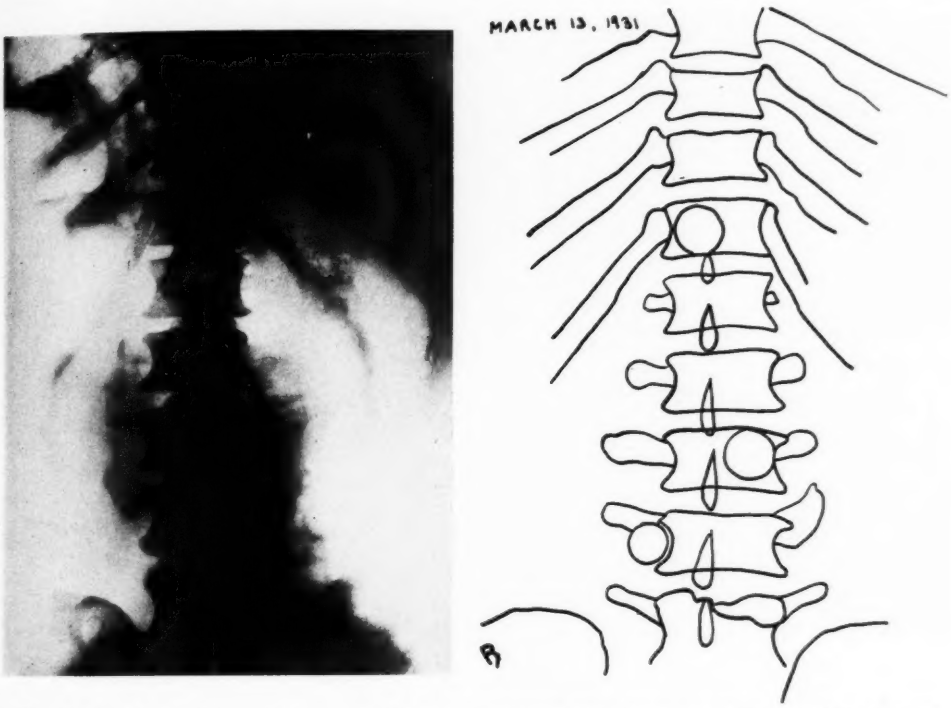
IX. The Vertical Projection Chart.—Since all points are charted (Fig. 4) in a like manner, we will demonstrate only the plotting of the vertical projection of Tr.3: (1) Line V.T.1—Tr.3.T.1 is drawn; (2) Line V.T.2—Tr.3.T.2 is drawn. (3) These lines intersect at V.Tr.3, the vertical projection of Tr.3.

All other points are localized in the same way, so that when this has been done the vertical projection of all the points is demonstrated. This constitutes the vertical projection chart (Fig. 6-*A*).

X. The Depth Chart.—After the vertical projection chart has been prepared, these points are transcribed to a second sheet of paper (Fig. 6). A line A—B is drawn parallel to the axis of the localized skin points, that is, parallel to V.S.K.1—V.S.K.2—V.S.K.3dc.

Since all the points which go to make the depth chart are plotted in the same manner we will demonstrate only how the depth D.Tr.3 is plotted (Fig. 6): (1) Point V.Tr.3 is projected upon line A—B. Its projection is called "C." (2) Line V.Tr.3—C is extended to "E." (3) The image shift, S.Tr.3 is obtained from the transparent sheet upon which the x-ray data have been transcribed (Fig. 4). (4) Image shift S.Tr.3 is applied to the "standard depth curve" along its horizontal axis V.T.1—X (Fig. 5). (5) The depth D.Tr.3 is obtained along the vertical axis V.T.1—T.1 (Fig. 5). (6) Depth D.Tr.3 is now applied along line C—E (Fig. 6-*B*) so that C—H.Tr.3 is equal to D.Tr.3. (7) C—H.Tr.3 (D.Tr.3) represents the depth (used synonymously with *height*) of the third lumbar transverse process above the plane of the plate. In the same way the depth of the other anatomical structures (H.Tr.1, H.Tr.2, H.Sa.1, H.Sa.2) are plotted, as are also the depth of the skin points (H.Sk.1, H.Sk.2, etc.). The skin points H.Sk.1, H.Sk.2—H.Sk.8 are joined by a line which represents the actual skin surfaces. The depth of any anatomical structure beneath the skin surface is measured from the skin line to the appropriate point. Thus distance L—H.Sa.1 represents the depth of the first posterior sacral foramen beneath the skin surface.

XI. Application of the Localization Charts.—The completed charts are turned over to the anesthetist-neuro-surgeon who applies them in the following manner: (1) The patient lies face down, or in whatever position may be necessary. (2) The vertical projection chart is placed over the patient's skin so that the localized skin points superimpose those tattooed on the patient's skin. (3) The localized anatomical structures are projected from the chart to the patient's skin and marked with surgical mercurochrome or similar easily



Figs. 9-*A* and 9-*B*. Representing x-ray plate and "processed" plate from a patient submitted to nerve blocking. Note the relative difference in size of the first and fourth lumbar transverse process. Without x-ray localization the blocking procedure in such or similar cases would be met with failure.

visible skin preparation. The depth of each of these structures beneath the skin is obtained from the depth chart.

If a needle were inserted through a surgical mercurochrome skin point to the appropriate depth, it would strike the anatomical structure in question.

XII. The Derivation of the "Standard Depth Curves."—In all systems of localization by triangulation it is necessary to make two x-ray exposures. If the factors employed in the localization procedure (1, target-film distance; 2, target-shift distance) are known, a "standard depth curve," the height of the object in question above the plane of the x-ray film, may readily be determined (Fig. 5) by applying the image shift along the horizontal axis and reading the depth along the corresponding vertical axis.

Since in this section we employ "standard depth curves" to define the depth chart, we have thought it advisable to demonstrate how these curves are plotted. If, for some reason, one should wish to change the two known factors employed in the x-ray exposures, a new curve could then be plotted, employing the changed factors. The "standard depth curves" are plotted in the following manner (Fig. 7): (1) Rectangle T2—T1—V.T.1—V.T.2 is drawn, and is designated by the special name "depth localization rectangle." (T.2—T.1 is made equal to the target-shift distances; T.1—V.T.1 is made equal to the target-film distances). (2) Any point O, along T.1—V.T.1, is selected. (3) Line T.2—O is drawn, and extended to intersect line V.T.2—V.T.1—X in O.T.2. (4) At point O.T.2, line O.T.2—M is drawn perpendicular to V.T.2—X. (5) Along line O.T.2—M, line O.T.2—H.O is drawn equal to distance V.T.1—O. (6) Point H.O (horizontal projection of O) represents one of the points on the "standard depth curve."

Figs. 10-*A* and 10-*B*. Representing the x-ray plate and a "processed" plate from an experimental case. Observe the curvature as well as the relative sizes of the transverse processes. The dotted lines represent masses of osseous osteoproductive tissues compressing the corresponding nerves. They are certainly equal in size to the transverse processes and their positions without x-ray localization would make blocking hazardous.

This process is repeated until a sufficient number of points along the curve are plotted to form a curve, the "standard depth curve."

INDICATIONS

After becoming better acquainted with the necessity for the use of x-ray localization in connection with various neurosurgical procedures, especially therapeutic regional anesthesia and nerve block, the usual question arises as to just what type of conditions are amenable to this form of surgical relief. Without encumbering the reader, we will briefly summarize as follows:

The surgical relief of pain is no longer an experimental procedure. Physicians and surgeons facing the problem in which the pain syndrome is the outstanding factor no longer are apt to assume the attitude of passive expectancy. The necessity for efficient relief of the pain syndrome in various conditions became a well-recognized fact.

Under given conditions, the use of therapeutic nerve block in connection with the relief of various forms of pain presents definite advantages over other methods of surgical technic. For example, in such conditions as precordial pain, accurately performed therapeutic nerve block of the peripheral and sympathetic trunks will greatly assist in proper management of the patient. Yet it will not mask those sensations which could be considered as warning signals, and so the patient, although relieved of the agonizing pain, will perceive a certain amount of constriction during the cardiac attacks, which sensation will serve as a warning.

In instances of causalgia and reflex contractures, when the pain is unbearable and does not yield to even the most advanced therapeutic measures, surgical resection included, properly performed paravertebral nerve block and chemico-surgical neurolysis will not only relieve the pain and assist in speedy rehabilitation, but it will

also produce improvement in circulation in the parts affected.

In various forms of neuritis or neuralgic pain syndrome, developed as sequelæ of such traumatic injuries as, for example, strains in the lumbar region or post-traumatic injuries to other component parts of the spine and back, a therapeutic nerve block performed by fractional method will quickly bring about the desired recovery.

In instances of essential hypertension in which the conditions do not yield to the routine therapeutic measures, a preverte-

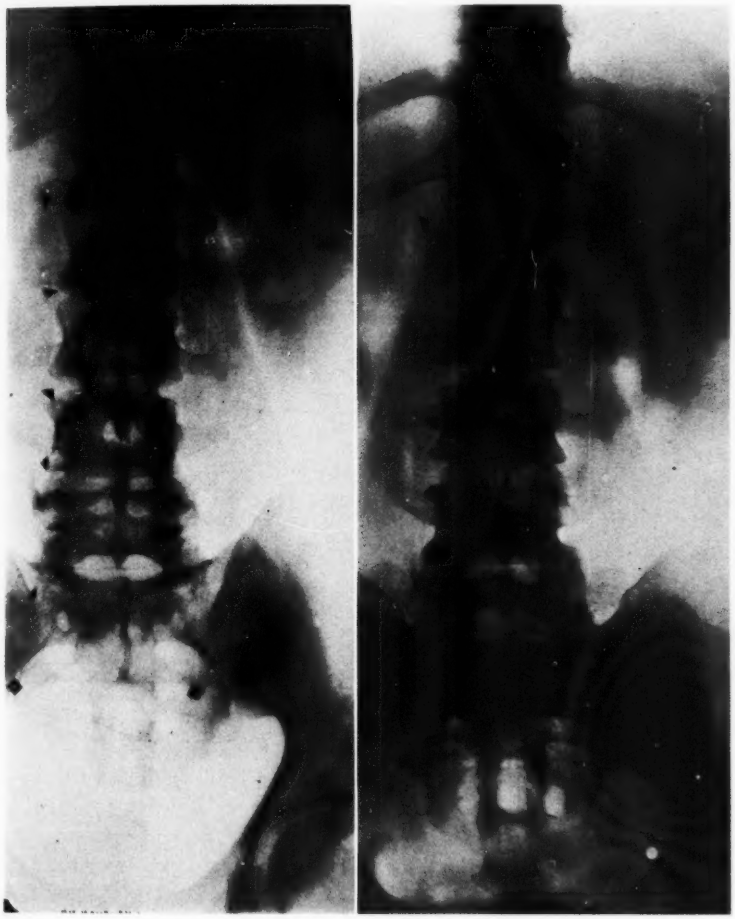


Fig. 11. Representing three-dimensional x-ray localization plate from a patient suffering from post-traumatic spur in the fifth and fourth lumbar regions. Without x-ray localization a proper type of nerve block would be difficult. The triangular marks represent the lead markers strapped over tattoo marks prior to exposure of the plate. The two square markers on the opposite side of the spine represent target points at which each individual exposure was made. The three-dimensional x-ray localization plate is prepared from such x-rays and serves for exact and accurate application of nerve block.

bral therapeutic nerve block of splanchnics or of semilunar ganglia not only will secure the much desired lowering of the blood pressure, which improvement will be relatively lasting and will compare most favorably in this respect with the more advanced surgical technics of sympathetic resection, but it also will permit

the repetition of the procedure at will should the indication warrant. The blocking technic, especially when x-ray localization is employed, is so precise and accurate that the degree of failure or danger is lower with therapeutic blocks as compared with the more radical surgical methods.

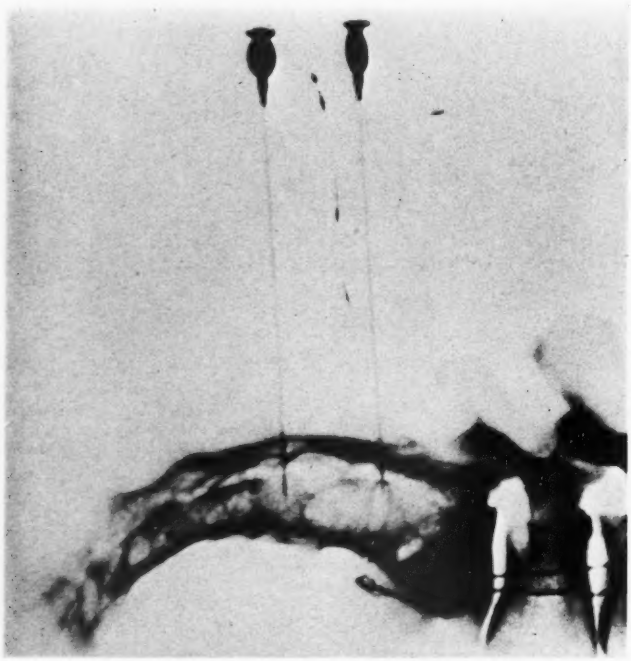


Fig. 12. X-ray plate from experimental case. The blocking needles are in their proper position in the sacral foramina. The depth to which the needles were advanced was precisely defined by our method. Note the danger of blocking needles passing through the sacral foramina to pierce and damage the pelvic structure if the depth has not been previously defined with accuracy.

During the treatment of narcotic drug addiction disease cases and in cases in which indication exists for speedy withdrawal of the drug, a properly administered therapeutic nerve block supported by deep sympathetic nerve block will fully control the major part of the withdrawal syndrome and assist in speedy, yet safe, rehabilitation.

In circulatory disturbances in diabetes, etc., when the circulation in the part affected is poor and when there is an indication for one or another form of sympathectomy, therapeutic nerve block should always be performed prior to such resection; in many instances it will bring about the desired relief, serving in other instances as an index of what could be expected from surgical resection.

In various orthopedic conditions in which existing pain syndrome hinders the recovery either because of actual pathology referable to the nerve trunks or because persistence of such pain syndrome prevents the application of the usual therapeutic measures, a proper type of therapeutic regional anesthesia will relieve the patient of the distressing pain, secure his co-operation, and permit the routine treatment to be fully beneficial.

Of course it goes without saying that the various measures spoken of should not be considered as a panacea, nor should they be promiscuously applied. Before any method of treatment is recommended the

patient should be thoroughly neurologically examined and various electro-diagnostical tests, as, for example, galvanometric

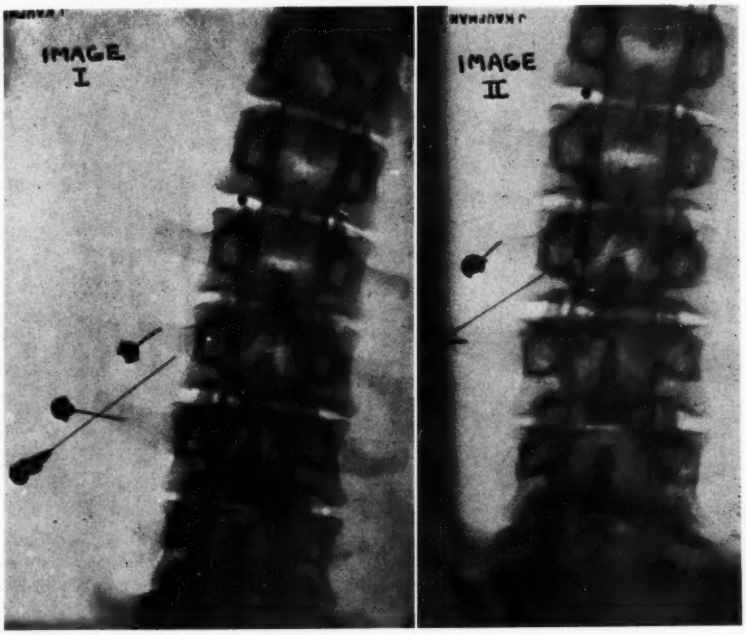


Fig. 13. Observe, upon Image I, the correct position of needles for nerve blocking. In Image II the blocking needle is easily advanced beyond the proper position if there is a lack of exact knowledge for guidance.

skin temperature recording, dynamometric tests, summation of stimuli test, conduction test, skin resistance test, etc., should always be performed in addition to the routine laboratory and x-ray examinations of the spine and the parts affected. Only by proceeding in such manner can successful and lasting results be secured.

CONCLUSION

In conclusion, we wish to state that the x-ray localization method is so simple, and its advantages in the surgical treatment of the pain syndrome in general and in therapeutic nerve block in particular are so evident, that no plea for its use in these procedures is necessary. It introduces into the field of neuro-surgery and regional nerve block a scientific method which permits individual correctness of application. It not only does not detract from the value and importance of any of the procedures, regional anesthesia included, but by simplifying the same it extends its field of usefulness and applicability.

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BIOLOGICAL INFLUENCE OF GAMMA RAYS ON THE GLANDULAR AND HAIR SYSTEM OF THE SKIN IN NORMAL AND PATHOLOGICAL CONDITIONS[1]

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THE biological influence exerted by radio-active rays on the skin and its glandular and hair system could be thoroughly studied on account of the easy direct observation of this tissue during all the phases of its reactive period.

The skin, considered as an organ in itself, does not passively endure any stimulation applied on any part of its surface, but presents various local and general reactions. Consequently, when we irradiate some part of our body through the skin, we must consider separately the biological reactive symptomatology of the skin in the irradiated zone, in the other parts of that skin region, and in other organs.

The study of distant reactions is peculiarly interesting whenever we regard the skin as the only way by which the influence of rays is transmitted, or when we take into consideration another factor, that is, the endocrine sympathetic system.

Let us consider now the way in which the different structures annexed to the skin react to the influence of radio-active rays.

First of all, let us observe the reaction of the hair system in normal and pathologic conditions, without obviously losing sight of the sebaceous and sudoriferous glands of the skin.

Since we are going to speak about the influence that rays exert on the skin, we shall first briefly mention the classic skin erythema which was considered in the past as a biological sign determining the efficiency of different doses of rays. As I have already had the opportunity of stating many times, the skin erythema is not an absolute biological test; in fact, this sign is not a constant one, as it depends upon different local and general conditions.

On the contrary, when we employ radium, applying it on a hairy region, as for instance the scalp, a dose of gamma rays from different crossed fields and by means of a molded apparatus according to the technic already described by me (since 1919), we always observe a constant biological reaction; that is, the complete falling out of hair at the end of a three-week period after irradiation, though we do not observe any estimable clinical alteration of the skin.

The growth of new hair, preceded by a *poussée* of thin down one month after the falling out of the hair, is a fact as sure as the defluvium itself; this statement is supported by the observation of nearly one thousand cases.

An important fact that we state in connection with our study of the biological reaction is that the quantity of new hair is greater than that of the fallen hair; the new is stronger, and its color is darker. (See Figs. 1, 2, and 3.)

In cases in which irradiation had to be repeated, as, for instance, in successive scab contagions, this reactive symptomatology was still more accentuated. Under the influence of radio-active radiations applied at an epilation dose, the hair root shows a sort of exalted reproductive functionality. The epilation dose has a siderating influence on the mother-cells of the hair papilla, with subsequent hair fall; the growth of new hair depends upon a local reaction of different, although always accentuated, intensity. This difference of intensity depends upon all the local and general factors determining every single mode of reaction (see Fig. 4).

If we insist in irradiating successively during a certain period of time, we see that the hair papilla begins to react in a different way. The germinating elements

[1] Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13–17, 1937.

Fig. 1 (*upper left*).
Fig. 3 (*lower left*).

Fig. 2 (*upper right*).
Fig. 4 (*lower right*).

react with an accentuation of the vital phenomena and the climax of radiosensibility corresponds to the period of the hair growth; consequently, if we intervene during this period, the absorption of rays will be greater, and their cytolytic influence stronger. Successive siderations intensify the local dystrophic manifestations, inducing gradually weaker reactions on the side of the cells, till at last they lose their reproductive power, so that the hair does not grow any more.

On this theoretical base we have founded the practical realization of our technic

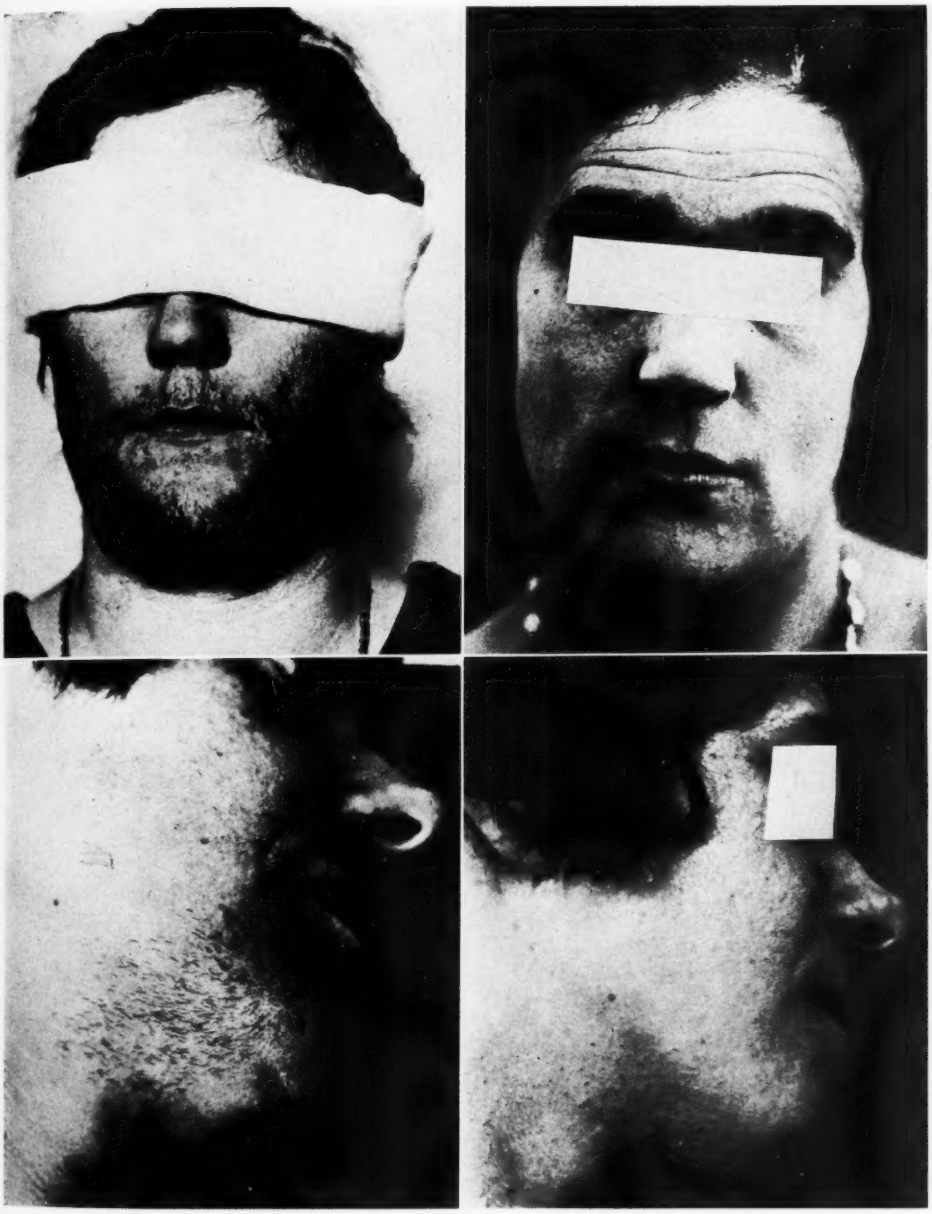

Fig. 5 (*upper left*).
Fig .7 (*lower left*).

Fig. 6 (*upper right*).
Fig. 8 (*lower right*).

of "cosmetical radium epilation in cases of feminine hypertricosis."

The hair defluvium always occurs without any clinically appreciable reaction on the side of the skin. The long experience we have in this field allows us to state that this method does not produce any such skin alteration as might possibly

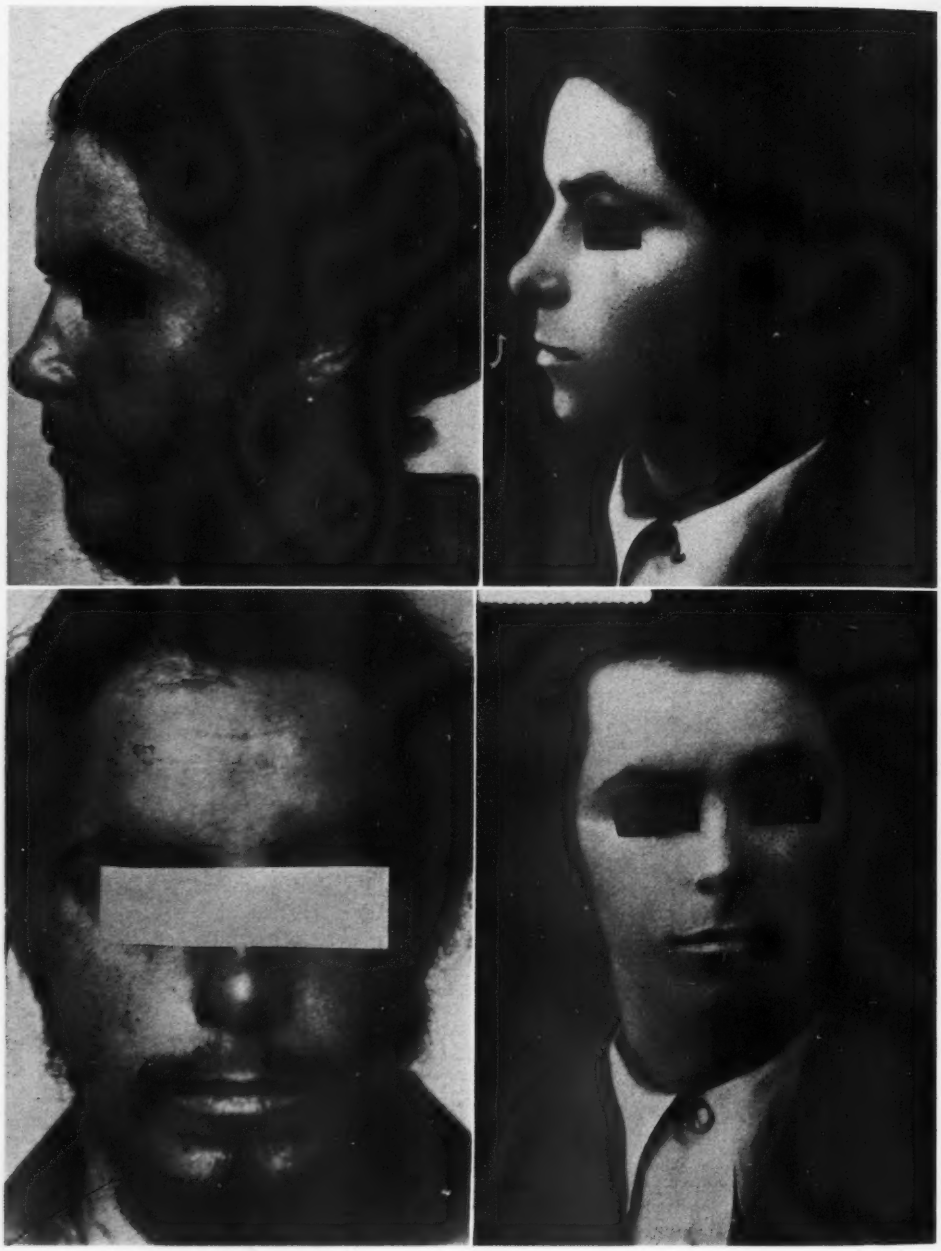

Fig. 9 (*upper left*).
Fig. 11 (*lower left*).

Fig. 10 (*upper right*).
Fig. 12 (*lower right*).

occur, even after a long period of time, in consequence of Curie therapy applied with a different therapeutic scope. In such cases the skin appears atrophic, dyschromic, with telangiectases and zones of radio-epidermatitis and radiodermatitis, as

Fig. 13 (*upper left*).
Fig. 14 (*upper right*).
Fig. 15 (*lower left*).
Fig. 16 (*lower right*).

a consequence of an altered nutrition caused by the intensive irradiations it has undergone (Figs. 5–16).

Rays pass uniformly through the skin, but their biological influence (that is to say, the absorption and the reaction of different parts of the skin) does not correspond to their physical homogeneity (quantity, quality of the irradiation, and penetrating power). One given kind of irradiation may have merely an inhibitory influence on the physiologic function of some structures, as for instance, the glandular tissue, whereas it is absolutely negative for connective tissue.

The increased secretory activity of sebaceous and sudoriferous glands (steatosis and hyperhidrosis) may be relieved by even a single irradiation which does not directly influence the glands, but controls the activity of the neurovegetative system upon which depends the glandular function.

Thus, in cases of acne vulgaris of the

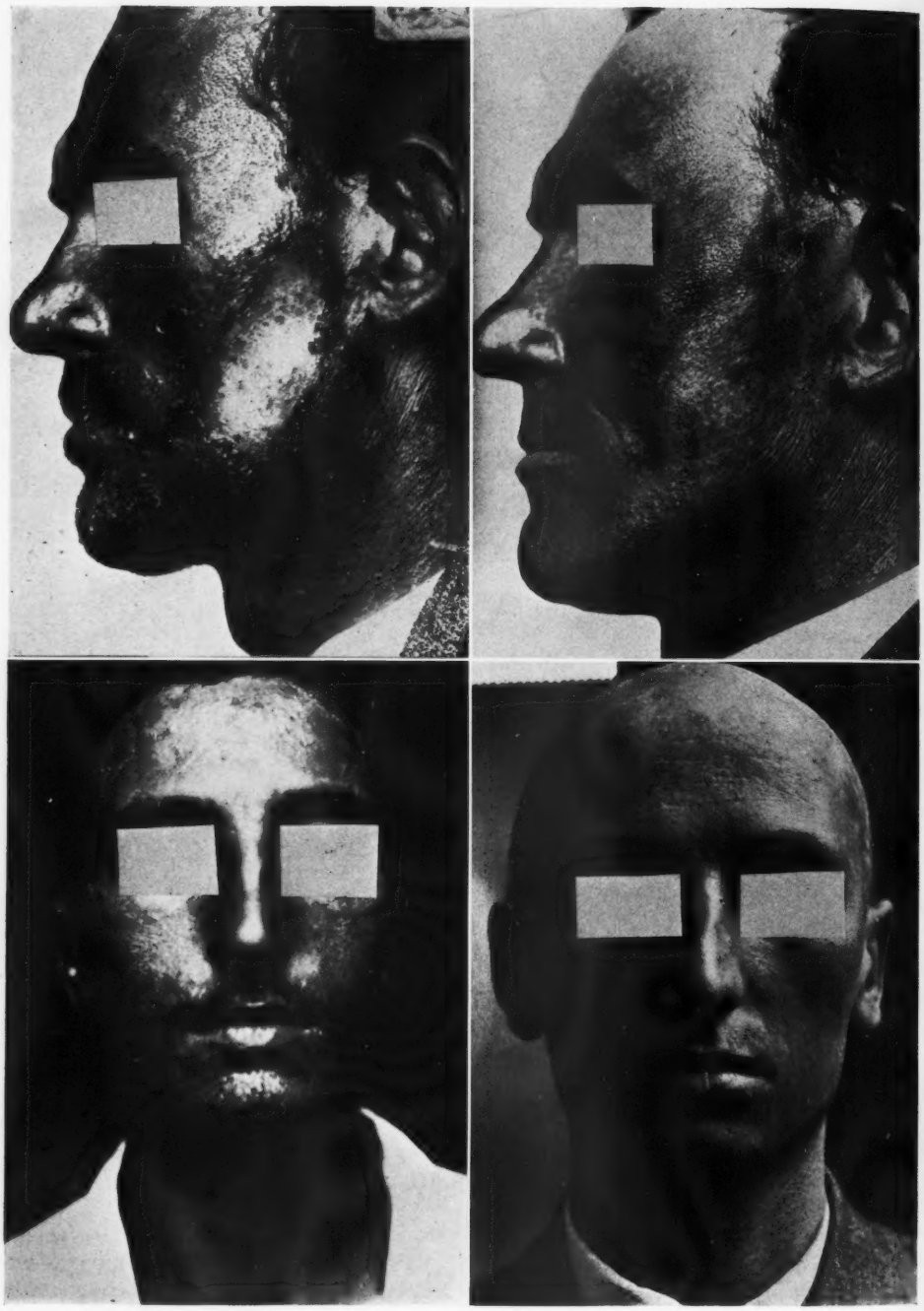

Fig. 17 (*upper left*).

Fig. 18 (*upper right*).

Fig. 19 (*lower left*).

Fig. 20 (*lower right*).

Fig. 21 (*upper left*).
Fig. 22 (*upper right*).
Fig. 23 (*lower left*).
Fig. 24 (*lower right*).

face, gamma rays do influence the glandular secretory elements, which are more radiosensitive than the other structures of the skin; even a single irradiation may bring about a complete recovery in those cases. Obviously this local therapy is applied after a general medical treatment of the patient (Figs. 17–20).

Fig. 25 (*upper left*).
Fig. 27 (*lower left*).

Fig. 26 (*upper right*).
Fig. 28 (*lower right*).

The same effects may be obtained in cases of local hyperhidrosis, especially if it be limited to the face, and particularly to the nose; gamma irradiation applied by means of molded apparatus gives us the possibility of obtaining in this region, too, an homogeneous subdivision of the dose in all the cutaneous and subcutaneous tissues.

We have had the opportunity of observing some regions of the scalp which had incidentally undergone epilation as a consequence of irradiation applied to neighboring regions. We thus had the possibility to state a fact which is very important from a radiobiological point of view: white hair falls and is replaced by darker, thicker and often curly hair even in subjects more than 70 years of age. (See Figs. 21–25.) This growth of dark hair, replacing the fallen white hair after a gamma irradiation applied at the epila-

Fig. 29 (*upper left*).
Fig. 31 (*lower left*).

Fig. 30 (*upper right*).
Fig. 32 (*lower right*).

tion dose, may be interpreted only as a rejuvenating process taking place in the hair system. In fact, the loss of pigment is generally a symptom of hair senescence.

The study of such cases observed during many years, with special reference to the general reactive organic powers and to the endocrino-sympathetic function, convinced me of the usefulness of employing this type of irradiation in the treatment of alopecia.

In fact, the first case I treated in such a way four years ago could not possibly present a better result than the one we obtained. It was a form of total alopecia of the scalp and of the eyebrows in a female subject, 21 years of age. The disease had already lasted three years and had resisted every type of local and general treatment (arsenical and phosphoric pluriglandular opotherapy, ultra-violet rays). (See Figs. 26 and 27.) We irradiated first one-half of the scalp and ob-

Fig. 33 (*upper left*).
Fig. 35 (*lower left*).

Fig. 34 (*upper right*).
Fig. 36 (*lower right*).

served a partial growth of hair, limited to the irradiated region; on the same side we observed the growth of some hairs of the eyebrow (Fig. 28). The second irradiation was applied to the left half of the scalp, but not on the whole surface of this region. Hair grew only in the irradiated zone; the part that had not been irradiated was still hairless. After this irradiation the left eyebrow was also restored. Menstrual disorders (dysmenorrhea) were controlled. (Figures 29 and 30; Figures 31 and 32 show condition after the second irradiation of the scalp.) The way in which this case reacted to the radio-active irradiations applied by us is worth some biological consideration.

First of all, it appears that gamma rays have a direct local therapeutic influence: the hair grew only in the irradiated regions. This influence may extend to more distant zones of the same side of the body, as we may see by observing the growth of the eyebrow. The irradiation has also un-

Fig. 37 (*upper left*).
Fig. 39 (*lower left*).

Fig. 38 (*upper right*).
Fig. 40 (*lower right*).

doubtedly an influence on the general conditions of the patient, as evidenced by the return of menstruations. In the first case a determining factor was represented also by secondary radiations of the skin, whereas in the second case this determining factor is to be found in an influence exerted through the endocrino-sympathetic system.

We applied this technic in different subjects of both sexes, who suffered from total or partial alopecia. In nearly all our cases we observed a new growth of hair which was more or less complete, with only few exceptions. In some cases we assisted to a new falling out of hair after a violent psychical trauma. One must not lose the hope of obtaining a new growth of hair after a second intervention, which must be made when the functions of the

Fig. 41 (*upper left*).
Fig. 43 (*lower left*).

Fig. 42 (*upper right*).
Fig. 44 (*lower right*).

neurovegetative system shall have acquired its full balance. (See Figs. 33–42, inclusive.)

After all the experiences we had in this field, we came to the idea of treating premature baldness, which grieves men perhaps still more than facial hypertricosis does women.

Our first results in this field were very favorable; after a period of defluvium which takes place particularly in cases accompanied by seborrhea, the hair grows in greater quantity than before, and white hair is substituted by dark wavy or even curly hair. Our colleagues, who were affected by baldness, were numbered among our first subjects; they were well satisfied with the results we obtained and are to-day the most convinced advocates of this therapeutic method, which they recommend as an absolutely harmless and very efficient one (Figs. 43, 44, 45, and 46).

Thus a new way is open in this field to

Fig. 45

Fig. 46

radiobiological study as well as to gamma-ray therapy. As we employ a special cap, gamma rays may be uniformly applied on the surface as well as in depth, notwithstanding the irregularity of the irradiated surface.

Facial hypertricosis of women, alopecia, and premature baldness are all real illnesses which may have an influence on social life and compromise nervous functions, possibly leading to a real form of phobia. The gamma therapy may bring about noticeable and sometimes even unhoped-for results. This method must be recommended in the interest of such patients, because only by its beneficial influence may they be restored again in such conditions as to perform serenely their duty toward family, society, and toward country.

DOSAGE, DURATION OF TREATMENT, AND REACTIONS IN PROTRACTED FRACTIONAL ROENTGEN TREATMENT, WITH SPECIAL REFERENCE TO CARCINOMA OF THE UPPER AIR PASSAGES[1]

By JENS JUUL, M.D.,[2] Chief Radiologist, Radium Center and Finsen Institute, *Copenhagen, Denmark*

IN the years 1931–1935 there were referred to the Radium Center in Copenhagen, in all, 151 cases of malignant epithelial tumors (sarcomas not included) of the hypopharynx, rhinopharynx, tonsil, base of tongue, and larynx. Of these, 41

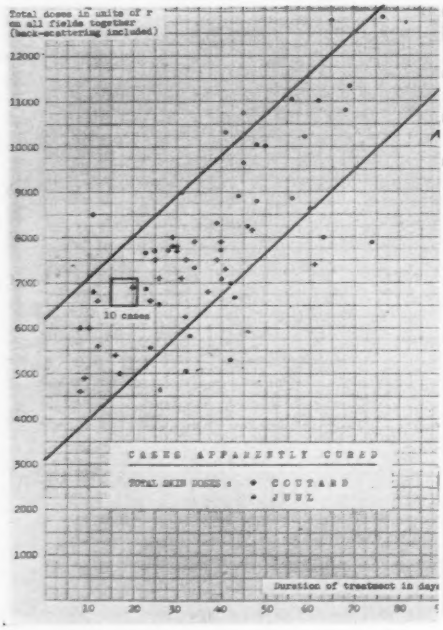

Fig. 1.

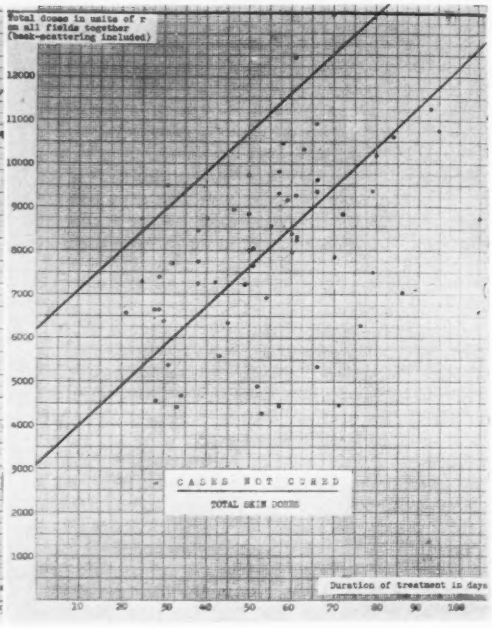
Total doses in units of r on all fields together (back-scattering included)
CASES NOT CURED
TOTAL SKIN DOSES
Duration of treatment in days

Fig. 2.

TABLE I.—TOTAL NUMBER OF CASES REFERRED, AND NUMBERS STILL SYMPTOM-FREE IN 1937

Referred	1931	1932	1933	1934	1935	Total
Hypopharynx (extrinsic larynx)	10–2	14–3	14–6	11–1	9–1	58–13 = 22 per cent
Rhinopharynx	5–3	2–0	7–2	7–3	7–1	31– 9 = 32 per cent
Tonsil	5–2	9–2	4–1	7–1	6–3	31– 9 = 29 per cent
Base of tongue	4–0	1–1	4–1	1–1	2–0	12– 3 = 25 per cent
Larynx (intrinsic)	2–0	1–0	6–2	7–2	6–3	22– 7 = 32 per cent
	26–7	27–6	35–12	33–8	30–8	151–41 = 27 per cent

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

[2] On Feb. 6, 1938, Dr. Jens Juul died of a severe attack of otitis. His Danish colleagues and the Danish League against Cancer regret the loss of a very able man who has given valuable clinical and scientific contributions to modern roentgen therapy. H. M. H.

(27 per cent) remain apparently cured in 1937. The cases free of symptoms are distributed with fair equality over the different years and among the different localizations. The therapy has been protracted fractional roentgen treatment, in only three

cases of tonsil cancer supplemented by radium and in one by electrosurgery. The absolute cure rate is shown in Table II.

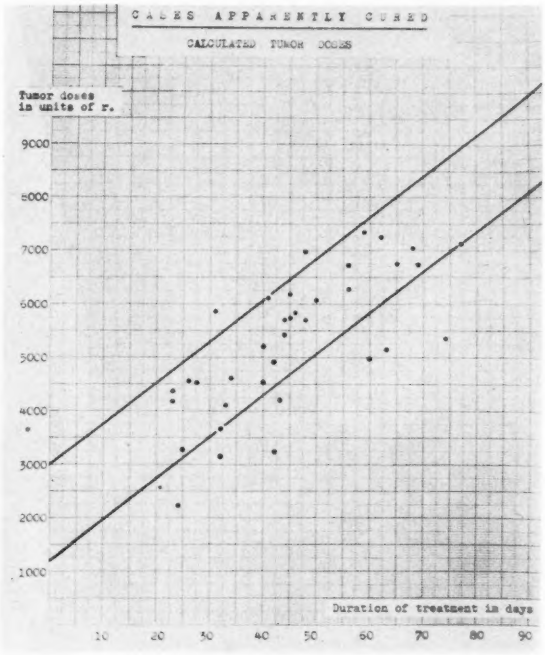

Fig. 3.

TABLE II.—ABSOLUTE CURE RATE

After at least 1 year,	45 of 151	(30 per cent)
2 years,	35 of 121	(29 per cent)
3 years,	25 of 88	(28 per cent)
4 years,	13 of 53	(25 per cent)
5 years,	6 of 26	(23 per cent)

For details of the treatment I must refer to a paper of mine.[3] The dosage has been mainly according to clinical criteria, while the physical dose—both daily dose, total dose, and treatment time—has varied considerably.

Figure 1 shows the symptom-free cases plotted in a coördinate system, the duration of the treatment (in days) being marked along the abscissa, the total dose on all fields together (back-scattering included) along the ordinate. The dots represent our own patients; the crosses, patients from Coutard's reports. In the small square are ten of Coutard's patients; 86 per cent of the cases lie within a zone which in width corresponds to a variation in dose of 3,000 r. This zone extends diagonally upward through the field in such a manner that to a longer treatment time there corresponds a larger dose. For each additional day of treatment time the dose is increased by about 90 r. To a dose of 6,000 r in 20 days corresponds a dose of 6,900 r in 30 days, 7,800 r in 40 days, etc.

Figure 2 shows the cases not cured which received over 4,000 r, plotted in the same manner as those in the preceding figure. They lie considerably more scattered; only 46 per cent lie in the "favorable" zone, 52 per cent below the inferior borderline. A cure has thus been obtained only in exceptional cases with doses of less than 4,900 r in 20 days, 5,800 in 30, 6,700 in 40, 7,600 in 50, or 8,500 r in 60 days. At the same time, the 48 per cent of cases not cured which lies above this borderline shows that though a dose of

[3] Acta Radiologica, 1936, **17**, 209.

higher value than these may perhaps be a necessary condition for obtaining a cure, it is, of course, not sufficient to *ensure* it.

curve, the speed of the elimination being at any given time proportional to the concentration of the "ray poison" at the

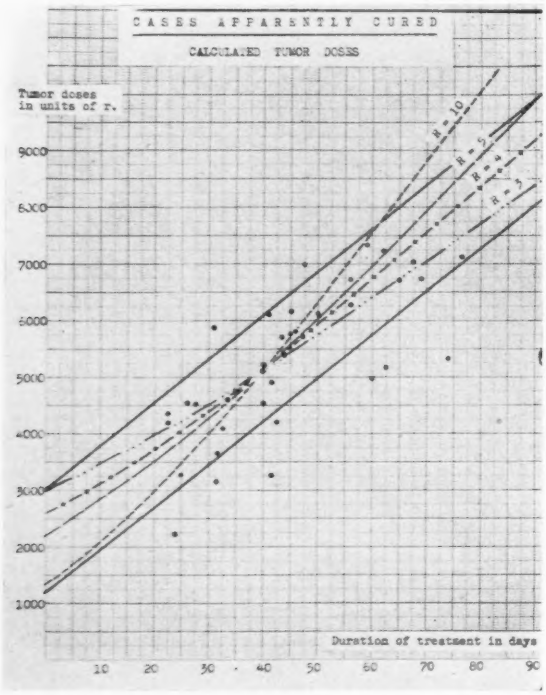

Fig 4.

Next, I have calculated the doses in the tumor itself, for my own symptom-free cases, and plotted them in the same manner (Fig. 3). It will be seen that most of them lie within a zone whose width corresponds to a variation in dose of 1,800 r; and again we see how the doses increase with the duration of treatment.

It seems to me that the necessity for an increase of dose when the treatment period is lengthened has a natural explanation in the possible capacity for recovery of the cancer cells from the ray lesion, and I have, therefore, tried to find out how these experiences may be made to fit with the Kingery-Pfahler theory concerning this recovery. As you know, the elimination of the "ray poison" from the tissues, according to this theory, follows a logarithmic

moment. The total doses which, if distributed evenly over a varying number of days should produce the same effect—or, to keep to the analogy of the "ray poison," the same concentration in the tissues—can be calculated by means of the following formula:

$$D_p = D_n \times \frac{p}{n} \times \frac{1-(1+R)^{-n}}{1-(1+R)^{-p}},$$

in which R is the rate of recovery per day, and D_p the total dose which, distributed equally over p days, gives the same effect as the dose D_n, if the latter is distributed equally over n days. The calculation will be exact only if the daily doses given have all been of the same magnitude. In my cases they have been so only approximately.

I have started from the dose 5,100 r in

40 days as values for D_n and n, as that is one of the best determined points; and have from there figured out D_p for various values of p and R. As Figure 4 shows, the curve for the recovery rate equal to 4 per cent is the one whose course corresponds best with the values that were found empirically. The application of the Kingery-Pfahler theory in regard to recovery after ray lesion thus leads to the acceptance of a recovery rate for tumor cells of about 4 per cent per day.

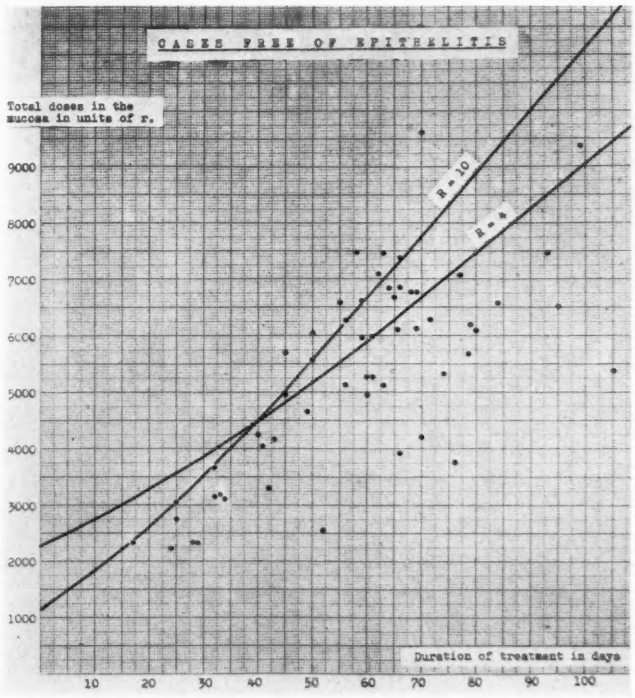

Fig. 5.

In a similar manner I have plotted (Fig. 5) the doses which we in our cases have been able to apply to the sound mucosa without provoking epithelitis. With the use of the same formula, and starting from the dose 4,500 r in 40 days as one of the best determined points of the upper margin, I have constructed the curves for corresponding doses for R = 4 and R = 10. It will be seen that the threshold values for production of epithelitis on the sound mucosa correspond best with the curve for R = 10 or more.

Finally, I have in Figure 6 plotted down the empirically found doses which had been applied to the skin of those patients who did not get exudative, but only dry, epidermitis. In calculating the doses, both the back-scattering and the dose through the neck from the other side have been taken into account. In the theoretical calculation of the corresponding doses under different rates of recovery, we have started from the dose of 5,700 r in 40 days. It will be seen that here also a recovery rate of 10 per cent per day is the one which corresponds best with the practical experience.

In Figure 7, I have set down together the three curves determined above, namely, the curves for the upper threshold doses for dry epidermitis, for the upper threshold

doses not producing epithelitis, and for the mean values of the necessary tumor dose. If we look at the relation in which perience that by extending the treatment over a period of six weeks or a little longer we make it far easier on the patient, with-

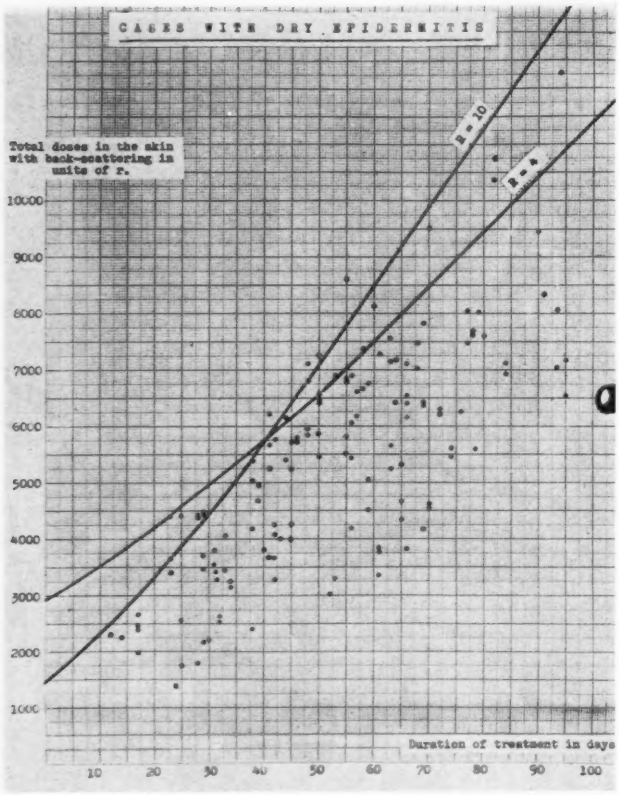

Fig. 6.

the curves lie to each other, we see that with a treatment time of less than three to four weeks it is not possible to make a tumor of medium sensitivity disappear without provoking exudative epidermitis or epithelitis. By extending the treatment over a longer period than four weeks it will, as a rule, be possible to avoid exudative epidermitis, and by extending it over a still longer period also the epithelitis may be avoided.

These partly theoretical estimates agree very well with our practical experiences. Considerable individual variations must be counted with; but it is my absolute ex- out depriving it of any of its efficacy. That the selectivity thus increases with longer treatment time, can be explained on the theory that the different tissues have different speeds of recovery.

After this we cannot consider the production of epithelitis on the mucosa as the object to be aimed at with the treatment, or as a condition for cure. Several experiences speak against conceiving the epithelitis and the exudative epidermitis as due to a directly epithelicidal effect of the radiation—as a matter between the epithelial cells and the x-rays alone. To me it seems more likely that the irradia-

tion produces inflammatory changes, especially exudation, in the corium and mucosa. If this exudation becomes so be observed directly on the skin a sub- or intra-epidermal exudate which disappears as soon as the outer layers of the epidermis

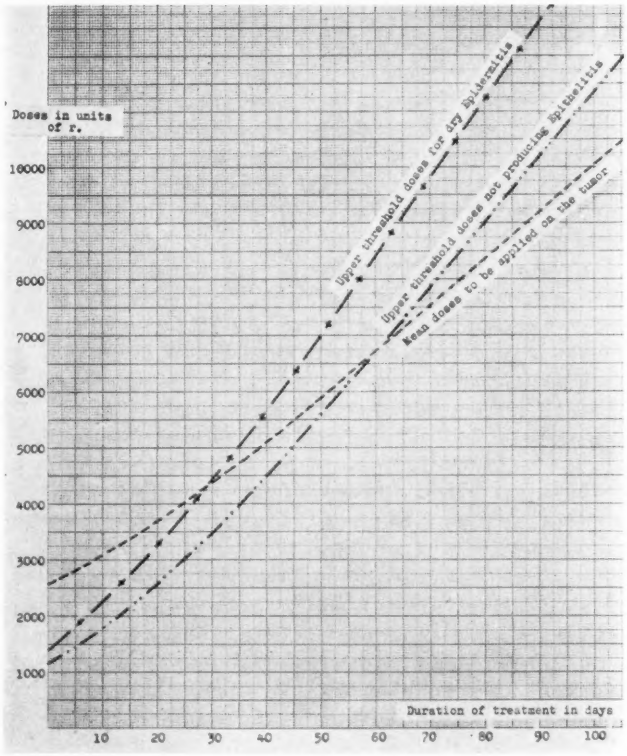

Fig. 7.

strong that the epithelium is shed, then we get the epithelitis or the exudative epidermitis; if the exudate is resorbed without the epidermis getting completely loosened, then we get the dry epidermitis.

The conception of the vascular and connective tissue changes as the primary is supported by various observations. There are several patho-anatomical parallels to the roentgen reactions in cases in which the epithelial changes are considered as secondary in relation to those in the connective tissue and the vessels. The degree of the reaction to irradiation depends very largely on other factors, which will intensify an inflammation. There may often, just before the reaction culminates, begin to dry up and get loosened. At the same time, the erythema disappears rather suddenly. Both the epidermitis and the epithelitis can be seen healing up, though the treatment is being continued with the same intensity as before. Finally, there seems to be a distinct parallelism between the degree of the exudative phenomena during the acute reaction, and the degree of the lasting changes, which have their seat in the vessels and connective tissue. The acute epithelial reactions to the irradiation must, therefore, probably be considered rather as secondary results of the direct effect of the irradiation on the vessels and connective tissue than as a direct effect of the rays on the epithelium.

THE APOPHYSEAL INTERVERTEBRAL ARTICULATIONS, ROENTGENOLOGICALLY CONSIDERED

By ALBERT OPPENHEIMER, M.D., *Beirut, Lebanon, Syria*

From the Department of Roentgenology, American University of Beirut

I. OBJECT OF STUDY

AS parts of the vertebræ, the apophyseal intervertebral articulations may participate in localized or systemic diseases of the spine: either directly, when affections of the vertebral bodies spread to the articular processes, or indirectly, when by pathological positions of vertebræ abnormal stress is laid upon the articular facets. On the other hand, as true diarthrodial joints, these articulations may become affected by the various forms of arthritis primarily, independently, and exclusively. It has gradually become evident that this distinction is significant for the treatment. Since anatomical findings in these conditions are not easily available, an attempt is here made to reach an interpretation based upon comparison of different stages of these diseases, and upon their correlations with certain clinical manifestations. The clinical aspect of the investigation is discussed in a separate paper. This report is concerned with the roentgen findings; it is based upon examinations of 162 patients with various affections of the apophyseal articulations, and upon a re-examination of more than 2,000 roentgenograms of parts of the vertebral column.

II. TERMINOLOGY

There is at present no uniformity as regards the classification of diseases of the spine. It is necessary, however, to come to some understanding about the signification of the terms in use. One may follow either an anatomical, an etiological, or a clinical conception. The clinical findings, as a rule, are not sufficiently distinctive (17), and an etiological classification is not yet possible (22); wherefore classification according to anatomical characters is at present preferable, though not final.

(1) *Spondylitis* is an inflammatory disease of the spine, spondylon, especially of the vertebral *bodies:* either rarefying, as in tuberculosis, or hypertrophic, as in low-grade infections and in mechanical irritation, resulting, for example, from thinning of the discs.

(2) *Spondylarthritis* is an inflammation of the spinal *joints*, arthron, namely, the apophyseal intervertebral articulations, there being no other true joints in the spine.

(3) *Spondylosis ossificans ligamentosa* is determined by ossification of the spinal *ligaments*, especially in the absence of changes in the vertebral bodies, intervertebral discs, and apophyseal articulations.

By eliminating from this classification such clinical terms as are correlated with various anatomical entities (*e.g.*, spondylosis muscularis, Bechterew's disease, and the like), it would be clearer and more exact to confine the terminology to the simple descriptive categories above mentioned.

III. TECHNIC: NORMAL APPEARANCE

Pathogenetically, the key structure of the apophyseal joint is the articular *cartilage* which is not directly visible roentgenographically. The width of the roentgenologic joint space and the appearance of the bony articular surfaces (facets) show indirectly whether or not the cartilage is affected.

Since the apophyseal joint spaces are quite narrow, deviations from a strictly perpendicular projection may lead by reciprocal overshadowing of the facets to superimpositions which are easily misinterpreted (Fig. 2). The position and direction of the facets that enclose the joint spaces vary in the several sections of

the column—cervical, thoracic, and lumbar. To the median (sagittal) plane of the body, the *cervical* facets stand at right-angles; the *dorsal* facets are slightly rotated forward, forming an angle of about 70° with the said plane, while the *lumbar* facets are strongly rotated backward to an angle of very nearly 45°. The respective positions of anode, object, and film are determined of necessity by these anatomical relations (Fig. 1); any other position, intermediate or approximate, cannot possibly reveal accurately the details which are essential for consistent interpretation.

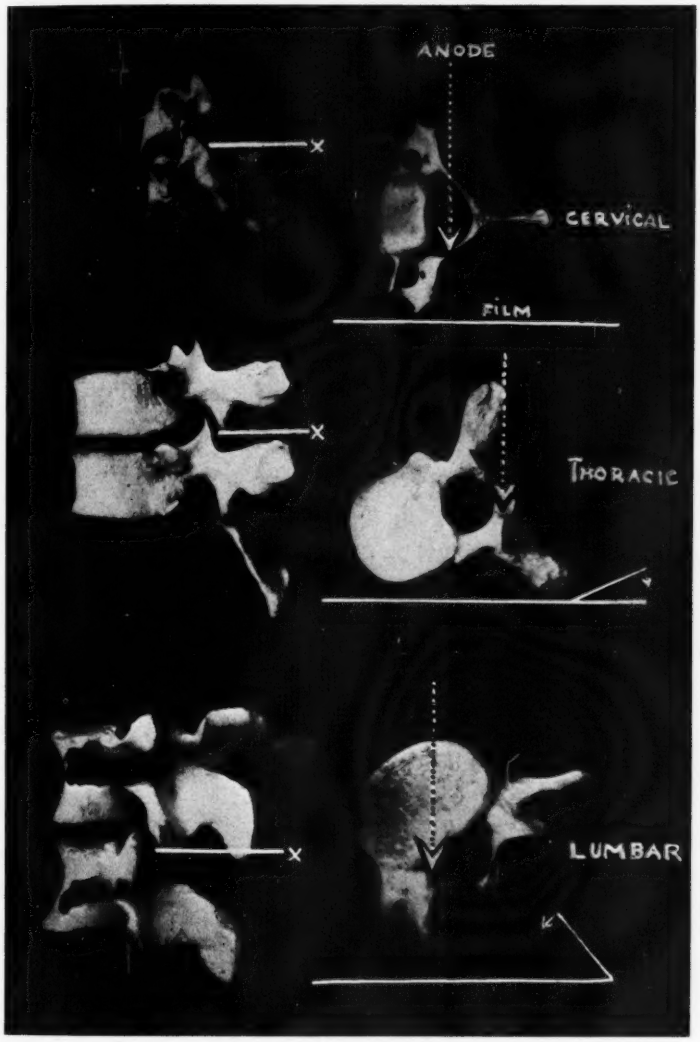

Fig. 1. On the left side of the picture, pairs of vertebræ are shown in the position in which the left apophyseal joint spaces stand at right-angles to the plane of this page. On the right side is shown the amount of rotation that is necessary to obtain this position in the cervical, thoracic, and lumbar regions, respectively. The vertical arrow indicates the direction of the central ray.

The following description applies to the *left* apophyseal joint spaces. For demonstration of the left *lumbar* joint spaces, the patient is placed with his back to the film, his left side being in contact with it, and his right side being raised to an angle of 45°. To show the left *dorsal* joints, he is posed with his left side to the film and is slightly rotated forward so that his right breast remains raised to an angle of 70°; if the patient, in the same general position, is rotated backward so that his right scapula remains raised to the same angle, the right dorsal joints, but not the left ones, will be projected perpendicularly. This contravenes one of the com-

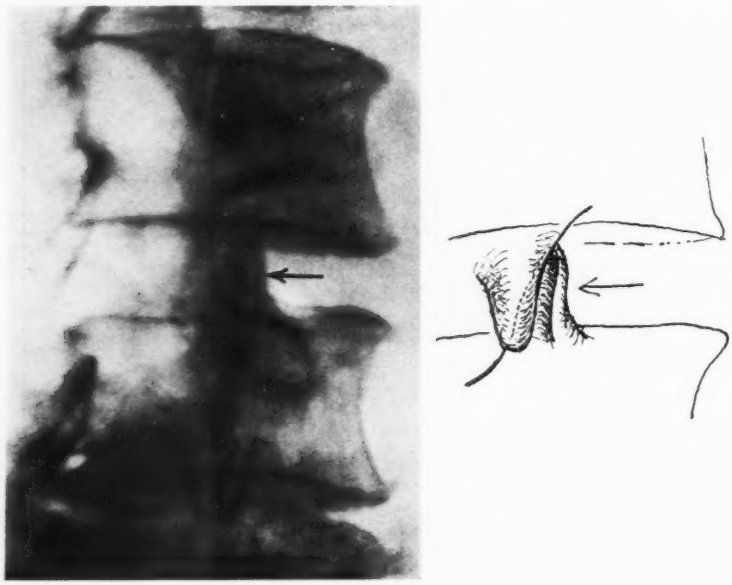

Fig. 2. The direction of the facets of the fourth lumbar vertebra (arrow) differs from that of the fifth lumbar in this case. Consequently, the fourth apophyseal joint is overshadowed (false narrowing).

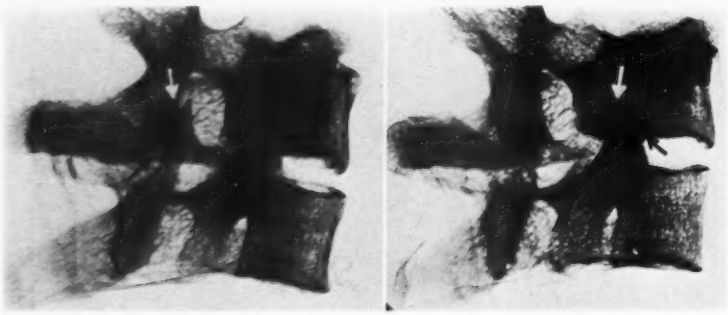

Fig. 3-*A*. Fig. 3-*B*.

Fig. 3. A flat piece of lead is inserted into a right dorsal apophyseal joint space. In 3-*A* the left transverse processes are rotated forward; the joint space projects perpendicularly (arrow). In 3-*B*, by backward rotation, the shadow of the lead projects as a plane (arrow), showing that the joint space does not stand at right-angles to the film. This confirms Bakke's objection to Lange's method.
Amount of rotation in either projection: 20 degrees.

mon technics (17, 7); but the simple experiment reproduced in Figure 3 proves that the position above described is correct. To demonstrate the left *cervical* joints, the patient is placed with his left side to the film, the median plane of the body being parallel to the film. The *twelfth thoracic vertebra* has superior articular processes of the dorsal type, rotated forward, but its inferior articular processes are of the lumbar type, rotated backward, hence two different views are necessary to show its joints.

"External landmarks" for centering the x-ray beam should not be used, for the relative position of the vertebræ varies according to size and shape of the chest and abdomen. By palpation of the spinous processes, the position of the articular processes is determined with sufficient accuracy.

The cervical and dorsal facets are very nearly plane, but the lumbar facets and the inferior facets of the twelfth thoracic vertebra are cylindrically curved. This curvature produces a summation of normal shadows which may simulate increased bony density, for the same reason as, *e.g.*, a thin layer of fluid in the pleural cavity, seen in the anteroposterior aspect, appears to be either more dense or more readily visible in the lateral than in the anterior and posterior pleural spaces (rule of the tangential projection, Fig. 4).

For interpretation of the findings, the following details are important: width of the joint spaces, outlines of the facets, position and bony structure of the articular processes, bony structure in the neighborhood of the articulations, relation of the articular processes to the vertebral bodies and intervertebral spaces, and condition of the ligaments with regard to ossifications.

Normally, the joint spaces are very sharply outlined by the facets; the latter stand parallel, with the tip of the superjacent articular process being exactly opposite to the base of the subjacent (Figs. 5-*A*, 6-*A*, 7-*A*). Although the transverse diameter of the articular processes is much smaller than that of the vertebral bodies, their opacity is equal to or greater, because the compact articular bone casts

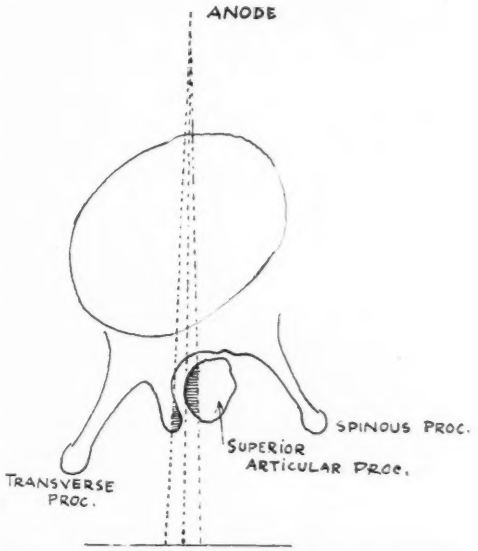

Fig. 4. The tangential projection of the curved lumbar facets makes them appear increased in density (see text).

a more dense shadow than the cancellous bone of the vertebral body. The cervical joint spaces, being inclined backward and downward, are diagonal in position; the dorsal almost vertical, and the lumbar vertical, *i.e.*, parallel to the anterior surfaces of the vertebral bodies.

IV. PATHOLOGIC CHANGES

(1) *Atrophic Arthritis.*—Swelling of the synovial membranes is rarely demonstrable. Only in the cervical spine in cases in which the intervening tissues are thin does this inflammatory thickening occasionally become visible as a foggy, soft shadow obscuring the joint space involved (Fig. 7-*B*). Moderate demineralization, mottled or diffuse, may then be seen in the articular processes. This inflammatory osteoporosis is more pronounced in chronic phases which are characterized by thinning of cartilage producing narrowing of the joint spaces (Figs. 6-*C*, 7-*C*). The facets remain paral-

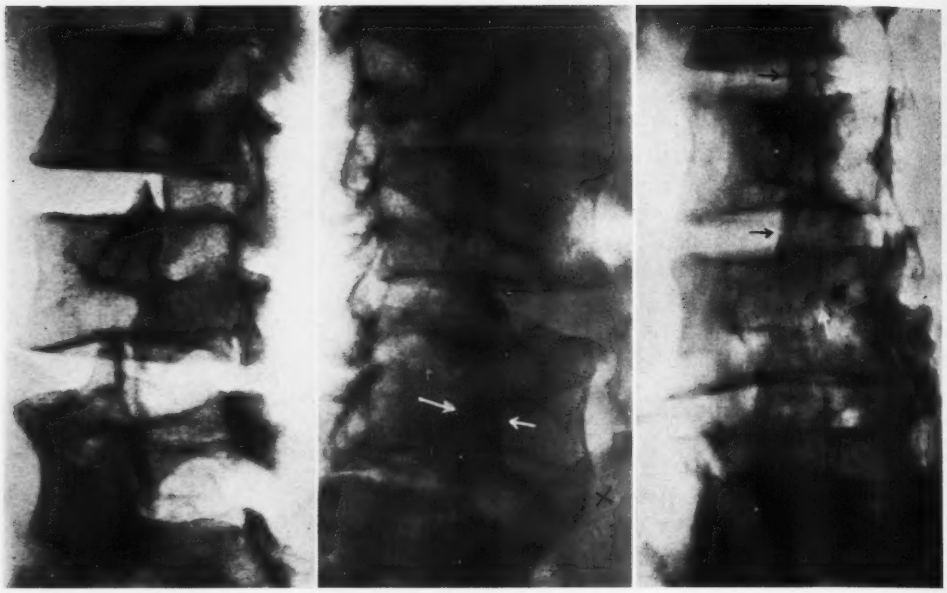

Fig. 5-*A*. Fig. 5-*B*. Fig. 5-*C*.

Fig. 5. Lumbar spine: Figure 5-*A* is normal. Note that tips of superior (subjacent) articular processes stand exactly opposite to bases of inferior (superjacent). Figure 5-*B*, hypertrophic spondylarthritis. Thinning of the lumbosacral disc (*x*); consecutive displacement of subjacent articular process, with marked eburnation and exostoses (white arrows) and obliteration of the included apophyseal joint space. Narrowing of the other apophyseal joints (black arrows), with eburnation and small exostoses (horizontal arrow). Figure 5-*C*, ankylopoietic spondylarthritis; vertebral bodies greatly rarefied; apophyseal joints ankylosed (white arrow); ligamenta flava ossified (black arrows).

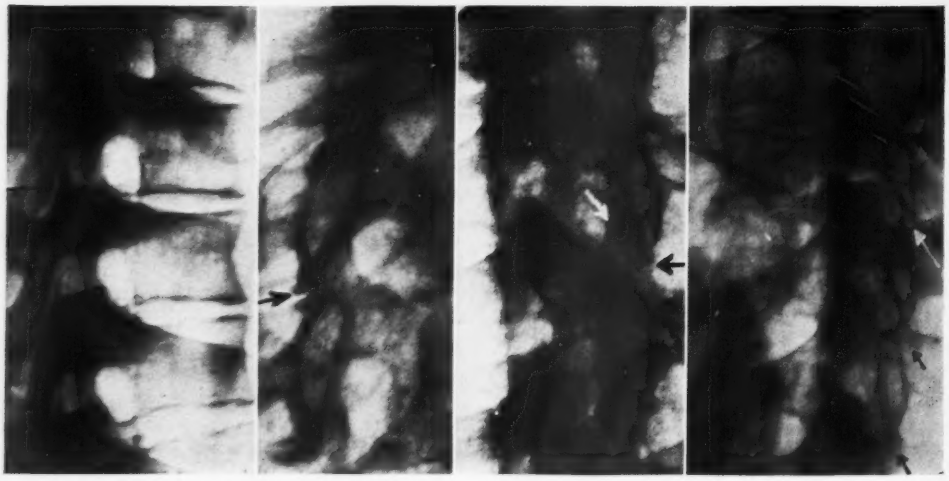

Fig. 6-*A*. Fig. 6-*B*. Fig. 6-*C*. Fig. 6-*D*.

Fig. 6. Thoracic spine: Figure 6-*A* is normal; Figure 6-*B*, hypertrophic spondylarthritis; joint spaces narrow, facets ragged, exostotic formations (arrow). Figure 6-*C* shows chronic atrophic spondylarthritis in one joint (black arrow); joint space narrowed, subjacent articular process rarefied (white arrow); the other joints are normal. Figure 6-*D* shows ankylopoietic spondylarthritis. One joint space is still faintly visible (white arrow); the others are filled with bony substance (black arrows). Because of the marked generalized rarefaction, the shadows of the ribs appear comparatively dense.

Fig. 7-*A*. Fig. 7-*B*. Fig. 7-*C*.

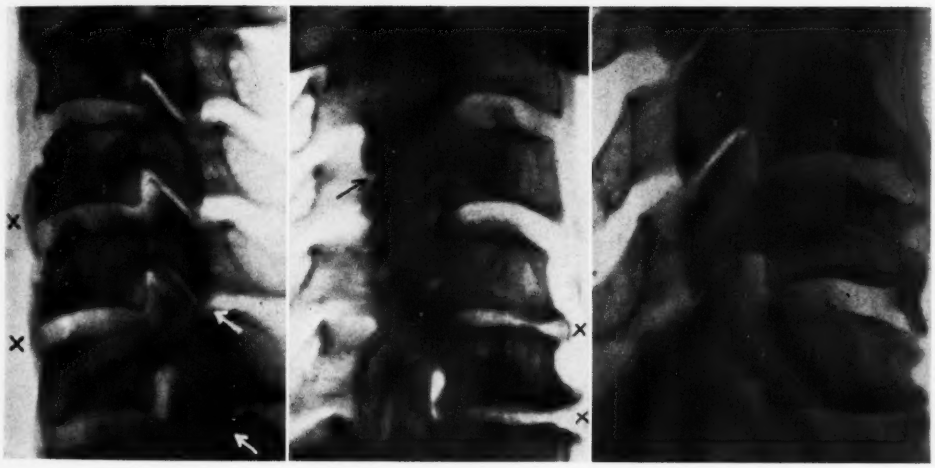

Fig. 7-*D*. Fig. 7-*E*. Fig. 7-*F*.

Fig. 7. Cervical spine: Figure 7-*A*, normal. Figure 7-*B*, acute spondylarthritis. One joint space obscured (arrow); the subjacent articular process shows slight mottled rarefaction. Figure 7-*C*, chronic atrophic arthritis. One joint space narrowed (arrow), the adjacent articular processes rarefied and thinned. Figure 7-*D*, ankylopoietic spondylarthritis. Same patient as shown in Figure 6-*D*. Two joint spaces narrowed (arrows); longitudinal ligaments ossified (*x*). Figure 7-*E*, hypertrophic spondylarthritis. One pair of articular processes greatly increased in density (arrow), the joint between them ankylosed. Intervertebral disc at this level normal. Below, two discs are thinned (*x*), but the corresponding joints are normal. Figure 7-*F*, spondylosis ossificans ligamentosa. Joints normal; discs normal. Deformity at the anterior margins of the vertebral bodies due to apposition of calcified ligaments.

lel, but are less clearly outlined than in adjacent normal joints (Fig. 6-*C*); hence the margins of the joint space appear indistinct or blurred. The intervertebral discs are not involved (Figs. 7-*B*, 7-*C*).

Under certain conditions (9, 17, 18) the disease may become systemic: a variable number of apophyseal joint spaces become narrowed, and the outlines of the facets may appear irregularly scalloped (Fig. 10-*B*). After an interval of at least twelve months, new bone forms on contiguous facets and gradually grows into the joint spaces (Fig. 6-*D*). Eventually these os-

sifications unite, thereby producing bony ankylosis of the articulations affected (ankylopoietic spondylarthritis). The ossified longitudinal ligaments (Fig. 11-*B*). The ligamenta flava, being involved in the proliferative inflammation of the synovial

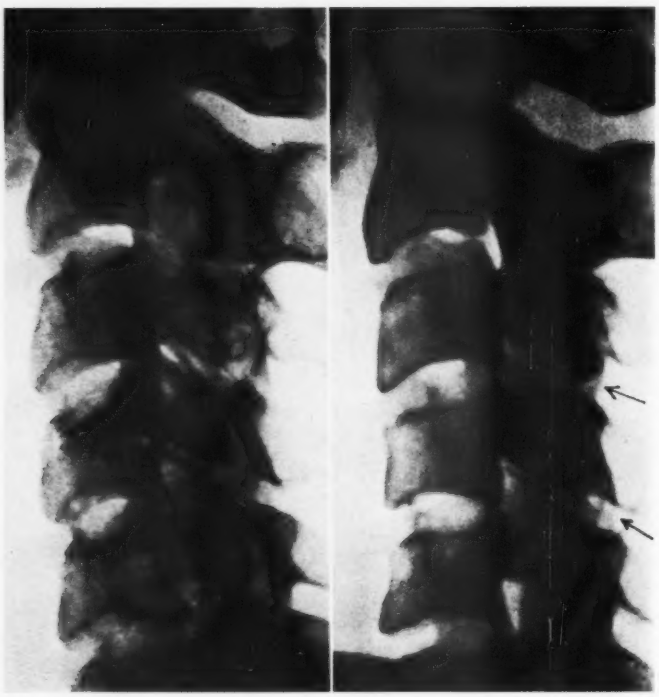

Fig. 8-*A*. Fig. 8-*B*.

Fig. 8. Cervical spine. Ankylopoietic spondylarthritis; 29 months' interval between Figures 8-*A* and 8-*B*. Note the increase in bony density after ankylosis has become complete (8-*B*). Ossified ligamenta flava (arrows).

process may become arrested and remain confined to a section of the spine (Fig. 12), or spread to other regions and gradually involve the entire column. As a rule, the iliosacral articulations are simultaneously involved (9) and may become ankylosed (Fig. 9), while the costotransversal articulations and the hip and shoulder joints participate less commonly in the arthritic process (21). The vertebral bodies are greatly demineralized in early phases (Figs. 9-*A*, 10, 11-*A*), but may regain almost normal density after bony ankylosis has become complete (Figs. 8, 9, 11-*C*). The intervertebral spaces remain normal in width, as the discs are not involved, but may appear overshadowed by membranes, commonly ossify simultaneously with the joints (Figs. 5-*C*, 8-*B*). Ossification of the longitudinal ligaments is common in advanced stages, but is neither constant nor pathognomonic, being a reaction common to a number of vertebral affections (4, 21). Ossification of these ligaments in the presence of normal intervertebral spaces produces the roentgenologic aspect known as "bamboo spine." Since the ankylosing process usually does not affect all the regions of the spine equally and simultaneously, various phases of the disease may be observed in different sections of the selfsame column.

(2) *Hypertrophic Arthritis.*—This condition is determined by a primary lesion

Fig. 9-*A*.

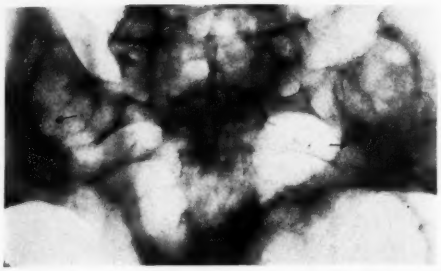

Fig. 9-*B*.

Fig. 9. Sacro-iliac articulations of the patient referred to in Figure 8; there was a 29-month-interval between 9-*A* and 9-*B*. Bony density increased after ankylosis became complete (9-*B*).

joint and at the adjacent surfaces. Only the alterations in the bones are visible roentgenologically. Hypertrophic changes may also develop in the course of some low-grade infection that is primarily associated with rarefaction, in which case the findings may overlap.

The narrowing of the joint space and the irregular outlines of the facets are similar in atrophic and hypertrophic spondylarthritis; but in the latter, the articular processes are increased in density. Small exostoses often form at the tips of the articular processes and at the facets, and bulge into the joint spaces (Figs. 5-*B*, 13, 14-*A*, 14-*B*). In other cases, these hypertrophic reactions are less conspicuous, and it may then become difficult to distinguish this type from atrophic spondylarthritis. The absence of rarefaction is in favor of the hypertrophic form, but it is especially the position of the articular processes which is of significance. As mentioned above, the facets remain parallel in atrophic spondylarthritis; whereas in the type of hypertrophic spondyl-

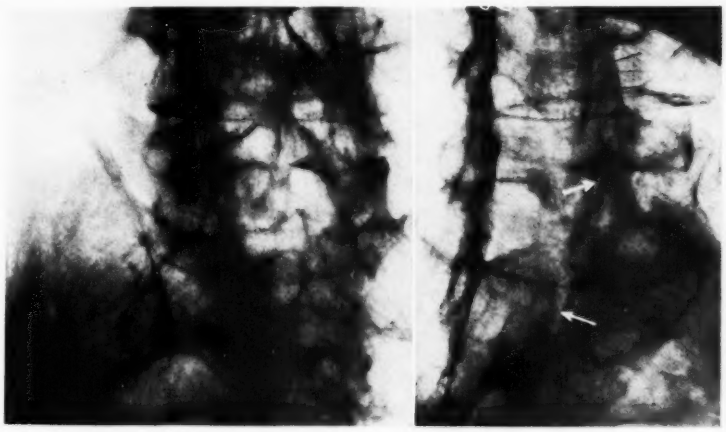

Fig. 10-*A*. Fig. 10-*B*.

Fig. 10. Lumbar spine; ankylopoietic spondylarthritis involving the sacro-iliac joints (10-*A*). Because of the generalized rarefaction, the column appears almost translucent. The arrows in 10-*B* point to the ankylosed joints. No calcification of ligaments. Anteroposterior and lateral projections would not reveal the significant findings in these cases.

of the cartilage inducing hypertrophic reactions of the various tissues within the

arthritis now discussed, they are either displaced or convergent; for this form

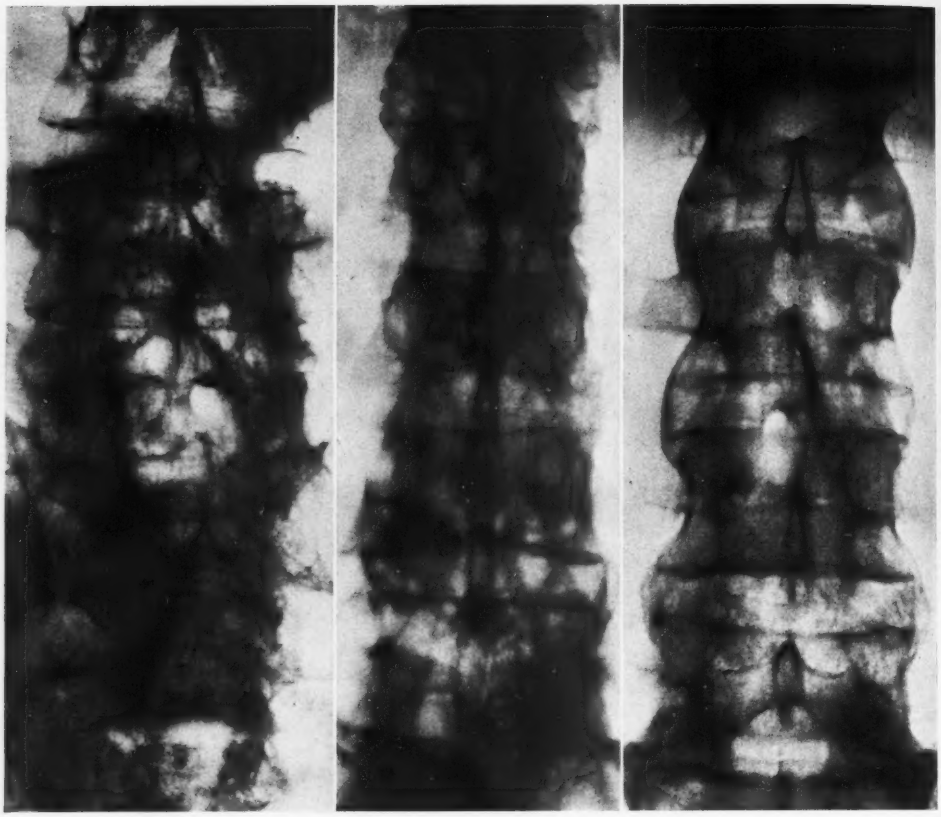

Fig. 11-*A*. Fig. 11-*B*. Fig. 11-*C*.

Fig. 11. Lumbar spine; three cases of ankylopoietic spondylarthritis at different stages. Figure 11-*A*, rarefaction predominates. Figure 11-*B*, the ossification of the longitudinal ligaments produces a "bony curtain" (4) behind which the rarefied vertebræ are indistinctly visible. Figure 11-*C*, ankylosis complete; pain subsided 14 months previously. The vertebral bodies, having regained normal density, project distinctly through the ossified ligaments.

seems to develop exclusively when by abnormal position of vertebræ the cartilage has been injured by the mechanical stress thus produced. These changes in position may result either from traumatic and destructive lesions of vertebral bodies, or as a consequence of thinning of the intervertebral discs (3, 17, 19, 23). In either case it is usually the articulation below the injured segment which is exposed to increased pressure (17). It is noteworthy that the articular cartilages may resist such persistent stress (21). (See Figs. 7-*E*, 13-*A*, 16.) On the other hand, the bones may not respond by hypertrophy to a present cartilage lesion: in this case, narrowing of the joint space and displacement of facets (when found associated with one of the statical alterations above mentioned) indicate the "hypertrophic" nature of the arthritic process even in the absence of bony hypertrophy (21).

Another type of spondylarthritis, obviously of different origin, is characterized by strongly marked bony hypertrophy of the articular processes, found in the absence of any of the statical alterations in question (Figs. 7-*E*, 13, 14-*A*). Clinical observations suggest a correlation with chronic amebiasis (6, 21, 22).

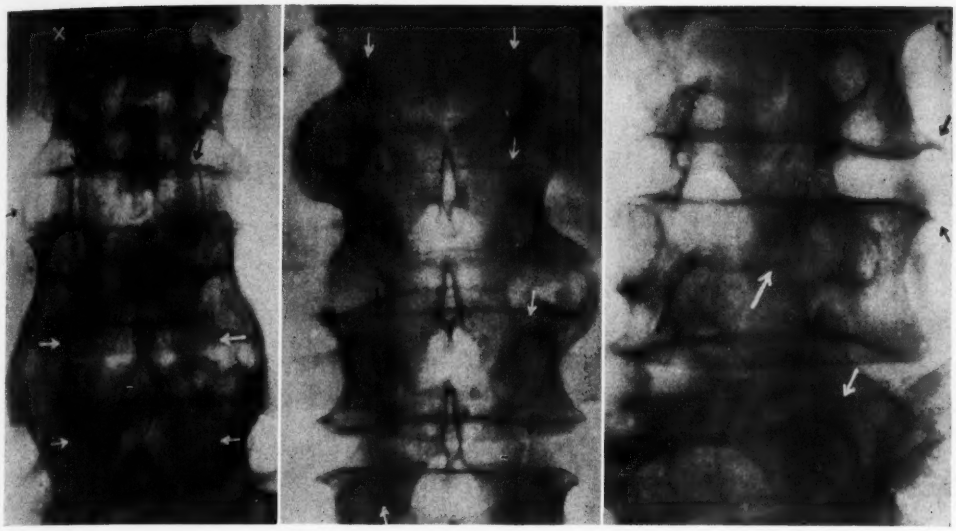

Fig. 12-*A*. Fig. 12-*B*. Fig. 12-*C*.

Fig. 12. Lumbar spine; arrested ankylopoietic spondylarthritis. Excepting for stiffness, the clinical symptoms subsided seven and eleven years before, respectively. The black arrows point to joint spaces that are still normal or almost normal; the white arrows, to narrowed or ankylosed joints. In 12-*C*, the black arrows indicate partial ossification of the anterior longitudinal ligaments.

Exostoses at contiguous facets may fuse (23); there results ankylosis of the apophyseal joint (Fig. 13-*B*). By the increased density of the articular processes, this ankylosis is distinguishable from ankylopoietic spondylarthritis.

The complicated interrelations between thinning of the intervertebral discs, hypertrophic spondylitis, and hypertrophic spondylarthritis are discussed in the clinical report.

(3) *Secondary Involvement.*—Both rarefying and hypertrophic osteitis may spread from vertebral bodies to the articular processes, though this is not very common. It would seem that the distant position of the articular processes as well as the greater resistance of their compact bone prevents the articulations from being easily affected. For example, in tuberculous spondylitis the articular processes have been found involved in only 19 per cent of our cases; the disease is often arrested before the articular processes are reached by the infection (Fig. 18-*A*). In osteoperiostitis (13), hypertrophic osteitis (Fig. 16), and Paget's disease (Fig. 17) the articular processes may participate in the vertebral affection; but the joint spaces often remain normal in width, and the outlines of the facets remain smooth. This corresponds to clinical and histological (13) findings which seem to indicate that

Fig. 13-*A*. Fig. 13-*B*.

Fig. 13. Cervical spine; hypertrophic spondylarthritis. Ankylosis (black arrows) by fusion of exostoses (white arrows). Narrowed intervertebral space at (*x*); the apophyseal joint at this level is normal (see text).

in this group of diseases the cartilages remain intact. On the other hand, the statical alterations that may result from these diseases may induce secondarily the type of hypertrophic spondylarthritis discussed above under heading 2.

(4) *Tumors.*—Destruction of articular processes by primary and metastatic tumors occurs occasionally. Erosion by tumors compressing the spine is very rare.

(5) *Fractures.*—Isolated fractures of articular processes seem to be more common

Fig. 14-*A*.

Fig. 14-*B*.

Fig. 14-*C*.

Fig. 14-*D*.

Fig. 14. Lumbar spine; hypertrophic spondylarthritis. Figure 14-*A*, primary, in one joint (arrow); no displacement of facets. Figure 14-*B*, "discogenetic" lesion with obliteration of one intervertebral space (*x*). Large exostoses (horizontal arrow); facets irregularly indented (arrows). Figure 14-*C*, the lower facets (arrow) are more strongly rotated than the upper ones. Nothing pathological; false narrowing. Figure 14-*D*, joint space narrowed; exostoses at articular processes (arrow).

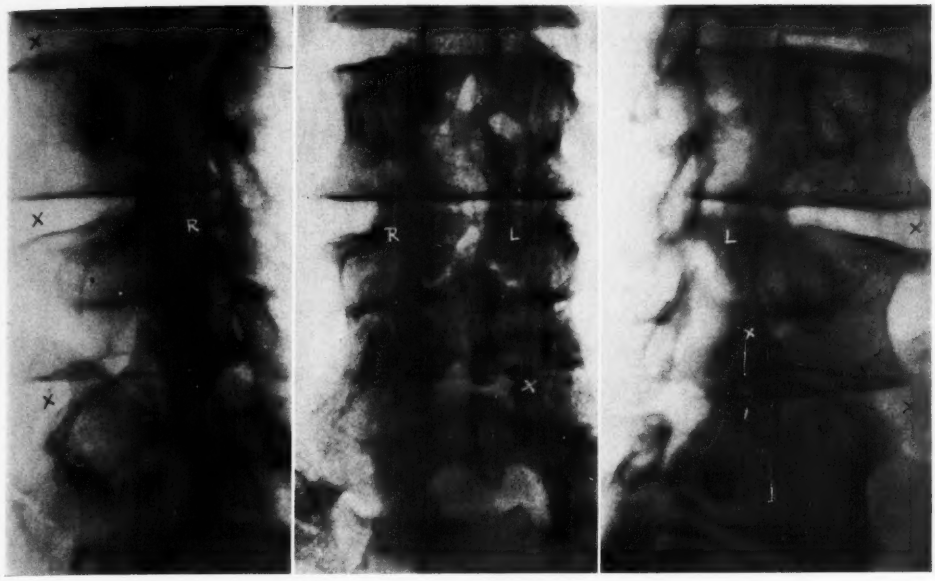

Fig. 15-*A*. Fig. 15-*B*. Fig. 15-*C*.

Fig. 15. Lumbar spine; "discogenetic" hypertrophic spondylarthritis. Three intervertebral spaces narrowed (*x*). Articular processes displaced; joint spaces narrowed; eburnation of facets. No hypertrophic reactions at the vertebral bodies.

in the cervical spine than in other sections. They are usually associated with compression fractures of adjacent vertebral bodies or with traumatic destruction of intervertebral discs. Callus formations are usually absent, even a number of years after the injury (Fig. 20).

(6) *Malformations.*—Congenital absence of articular processes is usually associated with other congenital malformations of a number of vertebræ (Fig. 21). Variations in size and shape are common in the lumbar region. Persistent epiphyses at the tips of lumbar articular processes may become displaced by trauma (Fig. 21).

(7) *Isolated Rarefaction of Articular Processes.*—This condition in which one articular process shows irregular rarefaction (19) is of interest merely because of its being invariably associated with severe radiculitis. The joint spaces remain normal (Fig. 19).

(8) *Spondylosis Ossificans Ligamentosa.*—This condition has no direct relation to spondylarthritis. It is marked by extensive calcification of ligaments; there are no other changes. Neither the vertebral bodies, the discs, nor the articulations are involved (Fig. 7-*F*). The thoracic spine is more commonly affected than other sections. In a particular form, only the ligamenta flava calcify (1). This type of ossification differs from that found in spondylarthritis ankylopoietica by the absence of changes in the apophyseal joints, but the distinction is not always easy, for the ossified ligaments may completely overshadow the joint spaces.

On the other hand, calcification of ligaments is quite commonly associated with various vertebral lesions, *e.g.*, spondylarthritis ankylopoietica, hypertrophic spondylitis, Pott's disease, and traumatic lesions. But it is characteristic of the form above described that it is independent of such changes, wherefore it would seem preferable to distinguish it from the ligamentous calcification associated with other spinal lesions. It seems as though the ligaments may calcify or ossify in

regions that have become more or less strongly immobilized either by a pathological process or by the physiological diminution of mobility which usually develops in the fifties.

V. CONCLUSION AND SUMMARY

The roentgenologic characters of the conditions discussed are classified in Table I. The results would seem to indicate that there is no difference in nature be-

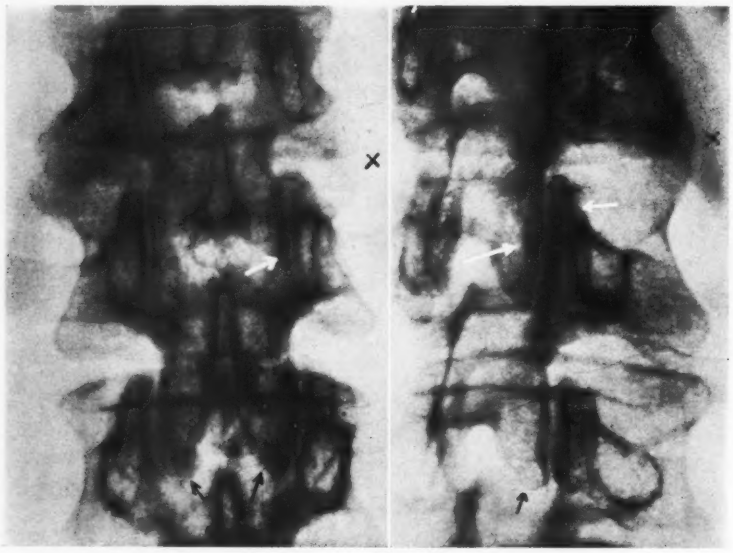

Fig. 16-*A*. Fig. 16-*B*.

Fig. 16. Lumbar spine; typhoid spondylitis with destruction of one intervertebral disc (*x*). The hypertrophic process has spread to the articular processes (white arrows) without involving the joint spaces. The black arrows indicate normal articular processes.

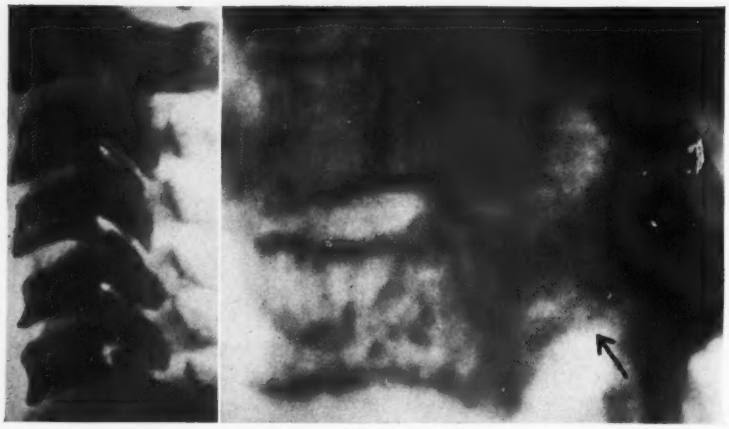

Fig. 17-*A*. Fig. 17-*B*.

Fig. 17. Paget's disease. Articular processes involved, joint spaces free.

TABLE I.—CLASSIFICATION ACCORDING TO ROENTGENOLOGIC ASPECT

Disease	Synonyms	Etiology	Anatomical Characters	Apophyseal Joint Space	Position of Facets	Capsule	Ligaments	Articular Processes	No. observations
(1) Spondylarthritis (*a*) Acute		Infectious	Inflammation of synovial membranes (osteoporosis)	Obscured	Parallel	Thickened	Not visible	Normal or slightly rarefied	7
(*b*) Chronic atrophic		Infectious	Inflammation of synovial membranes, inflammatory osteoporosis, thinning of articular cartilage	Narrowed	Parallel	Not visible	Not visible	Moderately rarefied, thinned	4
(*c*) Ankylopoietic	Spondylose rhizomelique Bechterew's disease Strümpell-Marie's disease Arthritis of spine Syndesmotic spondylitis[1] Spondylitis ossificans ligamentosa	Infectious; endogenous factors	Proliferative inflammation of synovial membranes, destruction of cartilage, pronounced osteoporosis, fibrous followed by bony ankylosis of facets, ossification of ligamenta flava (and longitudinal)	Narrowed or obliterated; later bony ankylosis	Parallel	Not visible	Flava ossified longitud. ossify at advanced stages	Greatly demineralized, may regain normal density after ankylosis has become complete	11
(*d*) Hypertrophic	Spondylarthrosis Trophostatic osteo-arthrosis Osteo-arthritis of spine[1]	Either infectious or due to statical changes	Ulceration of cartilage, eburnation of articular surfaces, villous hypertrophy of synovial membr., exostoses; ossification of intra-articular ligam.	Irregularly narrowed	Often Convergent	Not visible	Ossification inconstant	Eburnation of facets, exostoses at artic. processes	89
(2) Spondylitis (*a*) Tuberculous			Involvement of artic. processes inconstant					Rarefied or destroyed when involved	14
(*b*) Hypertrophic	Spondylosis deformans Spondylitis deformans[1] Osteo-arthritis of spine[1]	Low-grade infection, and consecutive upon thinning of discs	Eburnation and exostoses of vertebral bodies; calcification of longitud. ligam.; subluxation of artic. processes; secondary hypertroph. spondylarthritis (inconstant)	Irreg. narrowing[2]	Converg.	Not visible	Usually ossified[2]	Eburnation of facets, exostoses at artic. processes[2]	(72)
(3) Spondylosis ossificans ligamentosa	Spondylitis deformans[1]	Usually degenerative	Calcification of ligaments	Normal	Normal	Not visible	Calcified	Normal Other conditions observed	(18) 22 147

[1] These terms are variously used and do not define anatomical entities.
[2] These changes are not typical of spondylitis, but of the secondary involvement of the apophyseal joints.

tween arthritis localized in the apophyseal joints and arthritis affecting the articulations of the limbs. Calcification of ligaments may at times mask the similarity. As in other joints, arthritis of various origin and type becomes chronic when the articular cartilage has been involved. This may lead to divers secondary changes varying with mechanical factors, with the readiness of the adjacent bone to respond by reactive alterations, and possibly also with the etiology of the disease.

(1) The roentgenographic technic for examination of the apophyseal intervertebral articulations is described.

(2) There are three main types of pathological changes:

(*a*) atrophic spondylarthritis; acute, chronic, and ankylopoietic;

(*b*) hypertrophic spondylarthritis; primary, or consecutive upon abnormal mechanical stress;

(*c*) secondary involvement by various affections of the vertebral bodies.

(3) Affection of the articular cartilage,

Fig. 18-*A*.

Fig. 18-*B*.

Fig. 18-*C*.

Fig. 18-*D*.

Fig. 18. Pott's disease. Figures 18-*A* and 18-*B*, vertebral bodies severely affected (*x*), articular processes normal (arrows). Figures 18-*C* and 18-*D*, gradual involvement of the articular processes (11 months' interval).

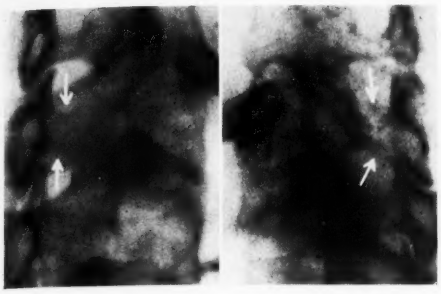

Fig. 19-*A*. Fig. 19-*B*.

Fig. 19. Isolated rarefaction of one articular process. Figure 19-*A*, normal; Figure 19-*B*, diseased side.

as made evident by narrowing of the apophyseal joint space, is the essential lesion in the different types of chronic spondylarthritis. Calcification and ossification of ligaments is not pathognomonic of any particular disease.

(4) A simple classification into (*a*) spondylitis, (*b*) spondylarthritis, and (*c*) spondylosis ossificans ligamentosa is proposed.

Fig. 20. Fracture of the left superior articular process of the first lumbar vertebra. Fracture line (small arrow); posterior displacement of the distal fragment (large arrow). Accident 16 months before; no callus formation.

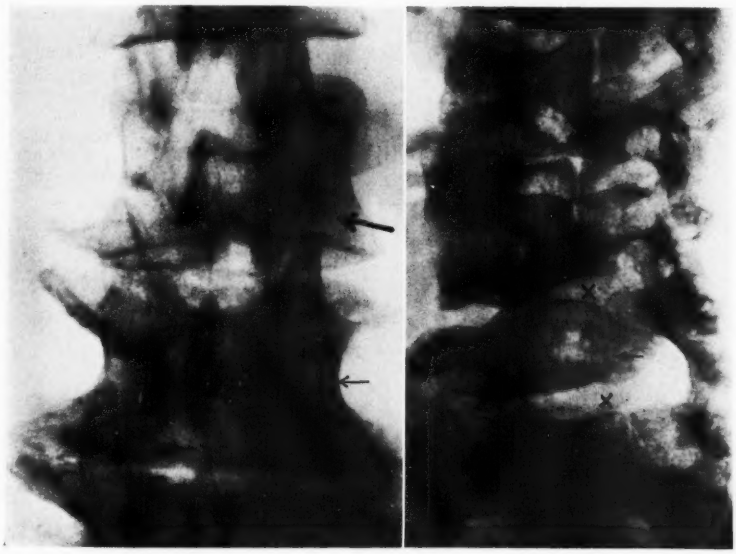

Fig. 21-*A*. Fig. 21-*B*.

Fig. 21. Congenital anomalies. Figure 21-*A*, displacement of a supernumerary epiphysis by a trauma associated with destruction of intervertebral discs. Figure 21-*B*, absence of articular processes (*x*); gap formations (arrow).

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PRIMARY BRONCHUS CARCINOMA

A DIAGNOSTIC AND THERAPEUTIC CONSIDERATION

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THE past two decades have witnessed a changing concept in our ideas regarding the pathology and diagnosis of primary bronchus carcinoma, but the proper therapy of these lesions still remains a much disputed issue. A summary review of the clinical and histopathologic diagnosis of this condition as seen here in our clinic is presented. Diagnosis and therapy will be stressed in the hope that eventually a sufficient series of case reports may be accumulated for future guidance in the most efficient methods of therapy of this serious lesion.

PATHOLOGY

Primary bronchus carcinoma was first diagnosed in this clinic in 1917. Since then, 73 other cases have been observed, but in only 65 has the clinical diagnosis, as suggested by history, physical, and x-ray examination, been substantiated by pathologic section. Of this histopathologic material available for study, the diagnoses were confirmed in 31 by autopsy; in 31 by biopsy of the primary (generally at bronchoscopy); in 9 by biopsy from metastatic foci, and in two by examination of the lung tissue removed at operation.

Although we fully realize the futility of any gross pathologic classification of these growths, we strongly feel that the arbitrary division of such lesions into those of peripheral and those of central or hilar origins, as suggested by Rabin and Neuhof, serves the practical purpose of assigning the possible operability of such lesions. We have thus attempted to so classify these 65 proven cases from the pathologic and clinical data available and have found only seven that were located near the periphery of the lung in contradistinction to the central origin of the majority. The relations of such finding to the histologic structure as occasionally suggested will be discussed later. A survey of the frequencies of metastasis and extensions as observed both clinically and at postmortem follows (Table III). Bone metastasis was noted in 19 cases and was observed in the following order of diminishing frequency,

TABLE I.—CARCINOMA BRONCHUS
AGE AND SEX INCIDENCE

Decades	Male	Female	Total Cases	Percentage
70–79	3		3	4.1
60–69	12	3	15	20.5
50–59	23	5	28	38.3
40–49	15		15	20.5
30–39	4	2	6	8.2
20–29	5	1	6	8.2
	62 or 85 Per Cent	11 or 15 Per Cent	73	99.8

Male: Female = 5.6:1

TABLE II.—CARCINOMA BRONCHUS

(The number of cases observed by five-year periods at the State Institute for the Study of Malignant Disease)

Years		Number
1917–21		4
1922–26		8
1927–31		13
1932–36		48
1917–36	Total	73

TABLE III.—METASTASES OR EXTENSION

Bones	38 per cent
Distant nodes	36 per cent
Lungs (other lung or lobes)	36 per cent
Regional nodes	34 per cent
Liver	20 per cent
Pleura	10 per cent
Adrenals	8 per cent
Kidneys	6 per cent
Pancreas	6 per cent
Esophagus	6 per cent
Brain	4 per cent
Pericardium	4 per cent
Auricular appendage and pulmonary vein	4 per cent
Intestines	2 per cent
Thyroid	2 per cent
Spleen	2 per cent
Diaphragm	2 per cent

i. e., ribs, 10 per cent; vertebræ or clavicle, 8 per cent in each; skull or femur, 4 per cent, in each; pelvis or sternum, 2 per cent in each. Only three of our cases showed brain or skull metastasis, a frequency much lower than that of Fried's and probably due to the fact that the brain was not routinely studied in our autopsy material.

One of the most striking features encountered was the number of cases in which the metastatic foci from the primary lesion so overshadowed or dominated the clinical picture as to produce in a fair minority of 11 cases no pulmonary symptoms at the time of admission here. These cases are herein referred to as those of atypical onset in contradistinction to the great majority with the usual pulmonary onset, or those which in the course of such pulmonary symptoms later develop additional signs and complaints due to extra pulmonary metastasis which are most difficult of recognition except by the acquirement of that eternal vigilance which becomes the outgrowth of the development of a bronchus carcinoma consciousness.

HISTOPATHOLOGY

We have assumed the unitary cellular origin from the basal cell deposits in the lowest mucosal layer of the bronchial tree as the basis for the observations which follow, especially for the marked pleomorphism displayed in these sections. In some specimens this phenomenon was so marked as to make it difficult to determine a predominating cellular arrangement or tendency. Generally, it was possible, however, to classify arbitrarily this material into groups depending on the predominating cellular arrangements or patterns, as shown in Table IV. Here we have assumed the adenocarcinoma to be the most differentiated group and, therefore, have placed these at the upper end of the table, followed by the squamous-cell group in the middle and the undifferentiated or anaplastic growths at the end. It is interesting to note that in such a classification the majority of the cases seen by us fell into the squamous-cell variety. We appreciate, however, that such percentage figures are of little significance and tend necessarily to vary in any such small series. We were unable to note any marked difference in respect to the average survival periods or metastatic propensities of the various types. These points will,

TABLE IV.—HISTOPATHOLOGIC CLASSIFICATION

(According to predominating cellular tendency)[1]

			No. Cases
		Cell Differentiation ↑	
Adenocarcinoma	I	Adenocarcinoma tendencies	
		(*a*) Non-mucus-producing with columnar cells lining acini	4
		(*b*) Mucus-producing	2
		(*c*) With cuboidal cells lining acini	0
Squamous-cell lesions	II	Squamous-cell tendencies	
		(*a*) Keratinizing (pearls)	22
		(*b*) Non-keratinizing	12
	III	Basal-cell tendencies (transitional)	6
Anaplastic	IV	Round-cell tendencies (medullary)	14
	V	Spindle-cell tendencies (oat-cell)	2
		↓ Cell Undifferentiation	62

[1] Based on the assumption of the unitary cellular theory of origin from the basal cell deposits beneath the bronchial mucosa as postulated by Fried.

TABLE V.—CARCINOMA BRONCHUS

Predominating Tumor Tendencies		Decades in Which Tumor Appeared						
		Second	Third	Fourth	Fifth	Sixth	Seventh	Totals
I_a	Adeno-		1	1	2			4
I_b	carcinomatous				1	1		2
I_c								0
II_a	Differentiated	2		5	13	2		22
II_b	Squamous Cell		2	3	2	4	1	12
III					5	1		6
IV	Anaplastic	4	3	1	4	2		14
V	Squamous Cell			1			1	2
All Groups		6	6	11	27	10	2	62

Available for grouping.

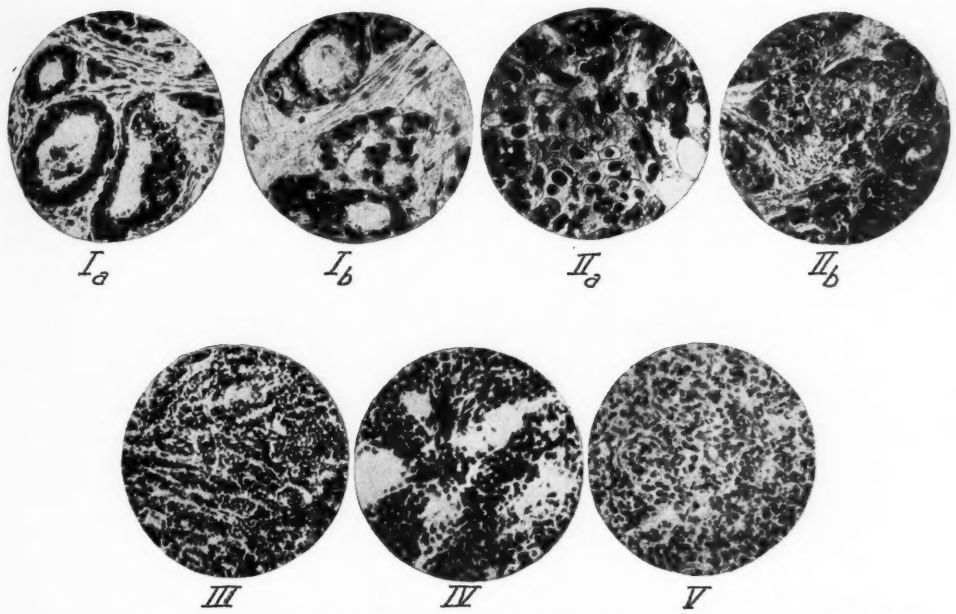


Fig. 1. The predominating histopathologic tendencies of bronchus carcinoma, arranged according to classification in Table IV. Special attention is called to the marked pleomorphic tendencies of this lesion, which in a few instances made such artificial grouping impossible.

however, be discussed more fully under treatment. No case of adenoma or carcinoid was seen although we were on the lookout for such in our material: neither could we observe any correlation between the age period of occurrence and the histopathologic grouping as observed by Geschickter in his series of 62 cases (Table V).

In our earlier records, it was interesting to note the frequency with which this lesion was confused with the lymphocytic type of lymphosarcoma, five such cases being discovered. Mention should be made here of the early work of Weller and others who have assisted in bringing to light the fallacy of such former erroneous concept. Seven cases in this series had previously been classified as "endothelioma of the pleura." We, like Stout, doubt the existence of such an entity, as on review of the sections all of these cases turned out to be bronchus carcinomas with extensive pleural involvement, showing the usual cellular tendencies as represented in the above classification. Five of these were classified by us in Group IV.

RADIOGRAPHY

There is no single finding or group findings that is absolutely pathognomonic of bronchus cancer. In fact, some early cases may apparently pass by routine chest roentgenography without arousing suspicions of this lesion (Fig. 2). It should, however, always be the custom to take at least postero-anterior and lateral radiographs of the chest in all cases in which the history or physical examination suggests

TABLE VI.—CARCINOMA BRONCHUS

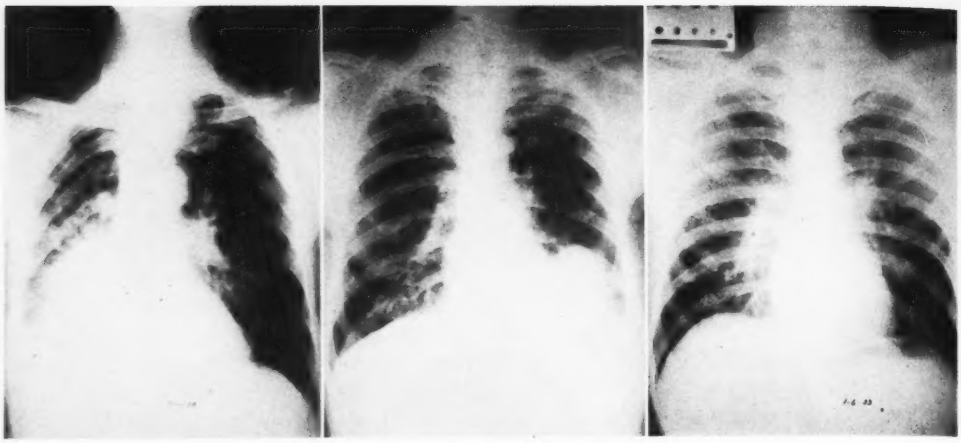
(Anatomical Location of Primary *vs.* Histopathologic Grouping)

Primary Tumor	Central or hilar location	49
	Peripheral	7
	Indeterminate	6
		62

(Seven Peripherally Located Tumors *vs.* Histopathologic Grouping)

I_a	I_b	II_a	II_b	III	IV	V
2	0	2	2	0	1	0

Note: From the above, there was no significant correlation between predominating pathologic trend or grouping and the peripheral location of the primary lesion.



A *B* *C*

Fig. 2. Chest radiographs of the three clinical types described above. (*A*) Central or hilus type, the most common. Incidentally note concomitant metastatic bone lesion in the left clavicle. (*B*) The parenchymatous or peripheral type, representing 11 per cent of our cases. (*C*) The type with non-pulmonary onset. Here, in this particular case, metastatic involvement of inguinal nodes first caused the patient to seek medical advice.

the possibility of bronchus carcinoma. By such routine, marked discrepancies between the roentgen findings and those obtained on ordinary physical examination often become all too apparent. Whenever the roentgen studies suggest the possibility of lung tumor, the case should be further investigated by bronchoscopy, thoroscopy, or a cellular study should be made of any chest effusion in the hopes of confirming suspicions from such biopsy materials.

Whereas the x-ray is not absolutely conclusive, nevertheless, it takes one of the most prominent parts in diagnosis on account of its easy facility in most cases, its usual superiority over ordinary physical examination, and the usual indirect signs observed which often suggest the necessity for bronchoscopy. The writer believes that the apparent frequency of bronchus carcinoma may be attributed mainly to the more frequent and systematic use of both the x-ray and bronchoscope rather than an actual increased incidence of this disease.

Under roentgenographic management of such cases we recommend a routine procedure of study using lipiodol, Potter-Bucky films, and artificial pneumothorax, if necessary, in addition to the usual postero-anterior and lateral chest films. We have found a single postero-anterior and a lateral film preferable in our experience to the routine stereoscopic postero-anterior pair, as we feel that more information can be gained from these two projections than is usually obtained from the stereo set alone.

Under roentgen findings it should be noted that a unilateral density, in contradistinction to the bilateral shadows as in tuberculosis, found in an individual past 30 should always obligate the examiner to rule out bronchus carcinoma.

These chest shadows may assume various characteristics commonly spoken of as being due to atelectasis, tumor mass, increased markings, abscess, effusion, etc. From a study of the x-ray films in our cases it would appear that increased markings may be one of the earliest signs. Atelectasis, on the other hand, is the most common early roentgen finding in the centrally located tumor, whereas tumor mass is the most common early finding in the peripherally located growth. Signs of abscess formation should be critically scrutinized as, according to Edwards, 10 per cent were later proven to be peripherally located lung cancer in the process of necrosis.

A classification of our findings in accord-

ance with a similar study by Manges and Farrell shows the following predominating x-ray characteristics in 38 cases of films available for study.

	50 Cases (Manges and Farrell)	38 Cases (S. I. M. D.)
Atelectasis	40 per cent	42 per cent
Increased marking	28 per cent	21 per cent
Tumor mass	24 per cent	13 per cent
Abscess or cavitation	6 per cent	9 per cent
Pleural effusion	2 per cent	15 per cent

The percentage variation in either series is of little moment because of the small number of cases involved except that it may tend to emphasize the probability of our cases being the more advanced when seen by us.

THERAPY

In accordance with the most approved views, the type of therapy will depend on anatomic localization of the lesion, *i.e.*, whether central or peripheral, and the histopathologic structure as shown by biopsy. The ideal cases for lobectomy or pneumectomy should be the peripherally located mass not accessible to the bronchoscope, with no hilar, mediastinal, or metastatic involvement or a lesion found on bronchoscopic biopsy to contain no mitotic figures, not too central in location and more recently classified as adenoma or carcinoid. In fact, a critical review of the cases surviving a year or more after such radical surgical procedures would lead to the possible suspicion that many of such cases to date might fall into this carcinoid category. Two of the cases of typical bronchus carcinoma in our series subjected to total or partial extirpation of the lung, died of extension. In fact, Kernan doubts the efficacy of such procedures in proven carcinoma and states that he has yet to observe such a cured case. Overholt, on the other hand, reports two cases alive, respectively, 20 and 14 months following pneumectomy for carcinoma.

Whereas the surgical outlook may be generally unalluring at the present state of our knowledge, the radiologic prospects are about as bad or worse. The experiences of the Memorial Hospital as cited by Stewart, the Mayo Clinic experience as cited by Vinson, and that at Bellevue as recorded by Kernan surely leave little optimism for radiologic therapy. There are only a few authentic cases to be found in the literature of radiologic arrests of this disease, notably one of Gantenberg's with a three-year regression followed by recurrence; one of Kahler's of the "basal cell type" alive after nine years; and one of Myer's alive and well after three years.

Following the suggestion of Ehrlich and Hauptman, the writer has adopted the x-ray technic of Herrnheiser in addition to radon seeds and diathermy in cases in which it is suitable, in the latter cases of this series. This type of external irradiation consists in using large total doses of protracted x-ray therapy of long target distance through four or more portals directed toward the tumor, up to a total of 12,000 r. This has apparently given marked symptomatic and subjective improvement for 18 months in one recent case, although only slight increased aeration is noted in the chest films. The supplemental use of radium element needles in the bronchus, according to the suggestion of Meland, is applicable to selected cases.

A review of these cases according to histopathologic grouping and survival periods following diagnosis and treatment has been made and fails to reveal any significant relationship as regards these factors; neither is there in evidence any reason to suspect from this small series that any one histopathologic group may be any more or less malignant, be any more prone to metastasis or rapid extension, or more radiosensitive than any other group. This finding is quite in accord with the original postulated origin of bronchus carcinoma from the basal cell deposits of the mucosa and quite in line also with the general pleomorphism so much in evidence in reviewing this material.

Therapeutic results are very difficult of evaluation on account of the fact that most

cases in a radiologic series are generally the more advanced centrally located lesions which by their nature are quite unsuitable for any therapy, but as a last resort are generally consigned to the radiologist. In spite of this, however, a marked palliation and freedom from distressing symptoms after irradiation may be immediately expected in many. In a few, we feel that the irradiation has hastened necrotic processes in tumor and adjoining lung tissue with resulting early death by pulmonary hemorrhages. Whereas the average survival is slightly longer after therapy, *i.e.*, six months as shown in our cases as against 4.5 months in the untreated, we do not consider this difference as significant. Incidentally, it may be of interest to mention that in the series both cases operated upon showed marked squamous-cell characteristics, which group Vinson has suggested as probably most suited for radical chest surgery.

The longest survivals in this series were 18 months in one case and 12 months in two others. The average survival in seven cases that lived over eight months after treatment was 12.6 months.

From the above, therefore, it will be seen that radiologic results of treatment of these tumors, at least in our hands, has been chiefly palliative and far from encouraging. On the other hand, the marked pleomorphism even bordering onto anaplasia of these lesions, their inherent tendency to distant and early metastasis, and the greater preponderance of the less favorable hilar types should make these lesions more unsatisfactory for surgical procedures. Under the encouragement of frequent favorable radiologic response of the somewhat histologically comparable squamous-cell lesions of the tonsil, pharynx, and larynx, we are, therefore, inclined to advise redoubling effort and acumen in order to achieve earlier and better diagnosis and therapy, particularly for those patients who still will be reticent in submitting to as yet a possibly lethal exploratory thoracotomy in order to confirm the suspicious existence or questionable operability of a primary pulmonary malignancy.

SUMMARY

1. A review of 73 cases of bronchus carcinoma seen at the State Institute has been made, and of these cases 65 were proven by histopathologic section on biopsy or autopsy, or both.

2. Histopathologic studies of the available material in 62 cases revealed a marked pleomorphism in most, with a tendency to predominating cell types or groups, depending on the degree of differentiation, into adenocarcinomatous, squamous-cell, and anaplastic tendencies.

3. A grouping of roentgenographic characteristics showed atelectasis, increased markings, and tumor mass to be the three most frequent findings in the order mentioned. Atelectasis is a common indirect finding in the hilar or central variety and the direct visualization of the tumor mass is commonly seen in the peripheral tumors. No apparent association could be observed between the histologic type and the period of survival which in the treated cases was only slightly longer than in the untreated.

4. Neither radical surgery nor irradiation therapy seems at present to warrant much optimism in the majority of these cases. On account of the tendency to early and distant metastasis and the more advanced and unfavorable locations of the tumors seen by us, it seems advisable for us to persist in attempts at more intensive and better planned radiation therapy. We see few peripheral lesions and fewer patients who will submit to radical thoracic surgery.

5. Earlier recognition and therapy still remain the urgent cry, if better prognosis is to be expected.

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THE EFFECT OF FRACTIONAL ROENTGEN TECHNIC ON THE INCIDENCE OF VAGINAL FISTULÆ IN CARCINOMA OF THE CERVIX[1]

By FRANK RAYMOND SMITH, M.D., F.A.C.S., *New York City*

IN 1934 the writer published a report (1) of vaginal fistula incidence based upon the study of 2,852 case records of patients having carcinoma of the cervix. It has been stated (2) that the incidence found was too low, and it is true that it is lower than the incidence found by Graves (2) and his co-workers in treated cases; it is also true that the untreated cases in this study did have a lower fistual incidence than the untreated series reported by Behney (3) and Williams (4). This criticism of the actual figures is undoubtedly just, for all the patients whose records were included in this study were not autopsied, and only by autopsy could the minute, non-symptomatic fistulæ be detected. However, the general principle presented (that the incidence of vaginal fistula is higher in untreated than in irradiated cases, hence principally a manifestation of the progress of the disease rather than of injury by irradiation) still holds true and has been substantiated by these very critics of my actual figures, and by others (3).

Because the method of therapy was found to influence fistula incidence somewhat and because of the increasing popularity of divided dose x-ray technic, it seems reasonable to study patients treated for carcinoma of the cervix during this last four-year period while the use of divided roentgen dosage has progressively increased.

Table I shows the comparison of fistula incidence as previously reported (1) to be more than twice as frequent in untreated as in treated patients. All of these patients were treated by massive dose roentgen therapy.

[1] The patients used in this study were from the Gynecological Service of William P. Healy, M.D., at Memorial Hospital.

TABLE I.—INCIDENCE OF VAGINAL FISTULÆ IN IRRADIATED AND IN UNTREATED PATIENTS (1916 TO 1932)

Classification	Case	Fistulæ	Percentage
Irradiated and Living	575	12	2.0
Irradiated and Dead	2,277	82	3.6
Irradiated Total	2,852	94	3.2
Untreated Patients	96	7	7.2

Table II shows by the yearly incidence of fistulæ from 1933 to 1936, inclusive, that the patients with advanced disease had a somewhat higher incidence than those treated in the early stage. Also, the total incidence (4.21 per cent) is only slightly higher than the previously reported incidence (3.2 per cent) in a much larger series of patients. This table does not differentiate as to whether patients were treated by massive or by divided dose roentgen therapy.

TABLE II.—COMPARISON OF YEARLY FISTULA INCIDENCE IN PRIMARY CERVIX CARCINOMA TREATED BY X-RAY AND RADIUM AS TO STAGE OF DISEASE

	Early			Advanced			Total		
Year	No.	Fistula	Percentage	No.	Fistula	Percentage	No.	Fistula	Percentage
1933	11	1		106	8		117	9	7.6
1934	11	0		118	2		129	2	1.5
1935	15	1		104	6		119	7	5.8
1936	16	0		118	3		134	3	2.2
Total	53	2	3.9	446	19	4.26	499	21	4.21

TABLE III.—COMPARISON OF YEARLY FISTULA INCIDENCE AS TO METHOD OF X-RAY THERAPY USED

		Divided Dosage			Massive Dosage		
Treatment	Year	No.	Fistula	Percentage	No.	Fistula	Percentage
X-ray and Radium	1933	48	2	4.1	69	7	10.0
	1934	45	2	4.4	84	0	0
	1935	45	3	6.6	74	4	5.3
	1936	75	2	2.6	59	1	1.6
	Total	213	9	4.4	286	12	4.1
X-ray only	1933–1936	10	0	0	20	0	0
	Total	223	9	4.0	306	12	3.9

In Table III the yearly incidence of fistulæ is shown to be, in general, slightly higher for the patients treated by divided dosage than if treated by massive dosage. However, the total fistula incidence for the years 1935–1936, inclusive, is practically the same for the two methods. The low incidence in 1936 is thought to be due to the increased interval (at least one month for divided dosage and at least two to three weeks for massive dosage) between the completion of the roentgen therapy and the radium application. This time factor was increased in 1936, and radium was not given until the x-ray reaction had completely subsided.

TABLE IV.—YEARLY FISTULA INCIDENCE IN PRIMARY CERVIX CARCINOMA COMPARED AS TO STAGE OF DISEASE AND METHOD OF THERAPY

Treatment	Years	Total No.	Fistulæ	Percentage
X-ray and Radium	1933–1936	499	21	4.21
X-ray Only	1933–1936	30*	0	Only 1 alive (1934)
Radium Only	1933–1936	38**	0	15 are alive
Total Treated	1933–1936	567	21	3.7
No Therapy***	1933–1936	15	2	13.3
Total Treated	1916–1932	2,852	94	3.2
No Therapy***	1916–1932	96	7	7.2
Total Treated	1916–1936	3,419	115	3.3
Total not Treated***	1916–1936	111	9	8.1

* All advanced.
** Nine were early cases.
*** Too advanced at first visit.

In Table IV the summary of the fistula incidence according to method of therapy, if any, shows the incidence of fistulæ to be more than twice as great in untreated as in treated patients. This holds true in the patients treated from 1933 to 1936, and in the totals as well as in the previously published figures for 1916–1932. The 30 patients treated by x-ray only were all too advanced for any but palliative therapy, and the absence of fistulæ in the group as compared with the relatively high fistula incidence in untreated patients suggests that therapy prevents rather than causes fistula formation.

CONCLUSIONS

1. Vaginal fistula incidence in carcinoma of the cervix is more than twice as high in untreated as in irradiated patients.
2. Fistulæ are probably prevented more often than caused by irradiation therapy.
3. Divided dose roentgen therapy increases fistula incidence only slightly, if at all.

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DIRECT RADIOCINEMATOGRAPHY[1]

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ALTHOUGH the progress in radiologic apparatus and technic has been rapid and considerable, we must admit that there is still a great difference between the living organism and a mere roentgenogram. This is so because instantaneous roentgenography fixes the appearance of the living organs only during a fraction of a second of their period of movement. Since Roentgen's discovery, radiologists have endeavored to fix on the film the movement of the organs, but during these many years their efforts have failed for various reasons. Some of these may be listed as follows: lack of power and regular output of the high tension generators, fragility and insufficient electrical charge of the tubes, the low sensitiveness of roentgen-photographic plates, the difficulty in handling them (glass plates), and the limited illumination of fluorescent and intensifying screens. During the last few years, as a result of the great progress made in the construction of roentgenologic material, roentgen cinematography has become a reality and definitely has taken its place in roentgen diagnostic technic.

Until recently considered as a slightly fantastic and not very practical investigation, roentgen cinematography has now asserted itself as a procedure within the reach of every one, the results of which, in the study of the normal and pathologic morphology of moving organs, give us new hope and appear to have an importance as yet unsuspected.

I. METHODS OF ROENTGEN CINEMATOGRAPHY

If we consider the roentgen cinematographic processes at present in vogue, we find on the one hand, the roentgenoscopic method, which consists in filming the roentgenologic images which are projected in succession upon a fluorescent screen; on the other hand, the roentgenographic method which registers directly on a reel or a series of roentgenographic films a considerable number of ordinary roentgenograms, which are later transferred upon standard projection film.

(*A*) *Roentgenoscopic Roentgen Cinematography.*—This procedure belongs to the group classed under indirect roentgen cinematography, so-called because X energy is transformed into a form of energy that is easier to register.

The very short wave length of the roentgen beam is transformed into the longer wave length belonging to the luminous octave.

The principle of the method is as follows: with the aid of a powerful high tension generator having a constant debit, we illuminate a fluorescent screen as intensely as possible, and with a special motion picture apparatus, placed at a distance of from 1.5 to 2 m., we reproduce upon an extremely sensitive cinematographic film of small size, the images which are projected on the screen.

In order to catch these silhouettes at a rate of at least 16 films per second, the camera must be equipped with a very luminous objective, enabling one to record the images on the screen, which, after all, are not well lighted; hence the objectives should have a very short focus. Their weight reaches several kilograms for a diameter of from 10 to 15 cm.

For 25 years this was the only method in use; hence it reaped the benefits of all the research work and of all the improvements brought about by the technicians. These improvements included special condensers, special or interchangeable tubes, special fluorescent screens, film hypersensitized to such a degree that it could be preserved for only a few days, etc. The fluorescent screen is illuminated under a tension of

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

from 60 to 100 kv. or more, and with an intensity of from 60 to 80 ma. (except Djan; 15 to 25 ma.). The roentgenoscopic method was originated in 1910 by Lomon and Comandon, who utilized an objective of F: 1.55. In 1928, Luboshez presented to the Congress at Stockholm an objective with a focus of 1. Later on, followed in succession: Janker F: 0.99; Russell Reynolds F: 0.85; Djan F: 0.75 to 0.55, and at last, in America F: 0.50.

(*B*) *Direct Roentgen Cinematography.*—Aside from the experiments by Prof. Groedel, of Bad Nauheim, carried out through the aid of the firm Siemens, Reiniger-Veifa, of Berlin, and those by Porcher, of Paris, in 1926, up to the present time this method has not been in existence at all. Groedel's and Porcher's efforts, unfortunately, were failures and remained almost entirely unknown.

Four years ago, after many technical experiments and calculations intended to solve the mechanical difficulties, I became convinced that this method could actually be put into practice, and after two years of hard work, I succeeded in developing my first roentgen cinematographic apparatus (Fig. 1). My object was not to roentgen cinematograph entire organs but to reproduce the cinematic picture of parts of diseased organs, the study of which has practically escaped the roentgenoscopic method, and even ordinary roentgenoscopy; for instance, the gall bladder, the urinary system, hysterography, etc. My aim was to develop a practical method using only ordinary material; generator tubes, films, screens, etc., capable of bringing some light upon the normal and pathologic morphology of the organs in question. In order to attain this object, I produced two apparatus.

The first apparatus, with reel film, is based upon the principle of the ordinary motion picture machine, with intermittent motions by a Maltese cross. The difficulties of adaptation at the outset lay in the size of the film to be employed, as each picture measured 120 × 140 mm., and later, in the necessity of using intensifying

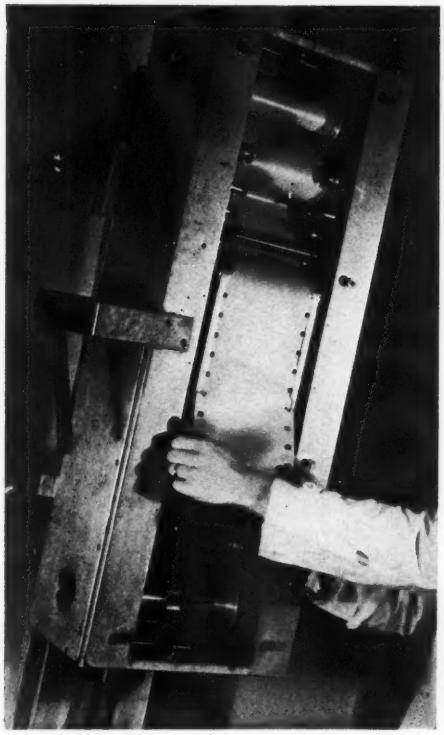

Fig. 1.

screens. While in the ordinary cinema, working at 16 pictures a second, only 35 cm. are unreeled per second, here about two meters must be unreeled; furthermore, the utilized surface must be unreeled from the intact reel as often as 16 times per second, must be brought before the camera gate and lens, completely immobilized without the slightest friction on the surfaces (in order to avoid scratches and static discharges), and also must be held firmly between the intensifying screens, exposed, released, and rolled on the exposed reel. One can easily conceive how the mechanism must be subjected to great jerky efforts, and the risk of vibration for the camera.

As for intensifying screens, they gave me no trouble; the rest was nothing at all. For films, I use Gevaert's ordinary films, which were graciously offered to me by the firm. The films have a marginal perfora-

tion every 2 cm.[2] The first tube I ever used was an ordinary 20 kv. Philips Rotalix, with a focus of 2.4 mm. This tube has from one-eighth to one-fifth of the erythema dose, according to the intensity employed.

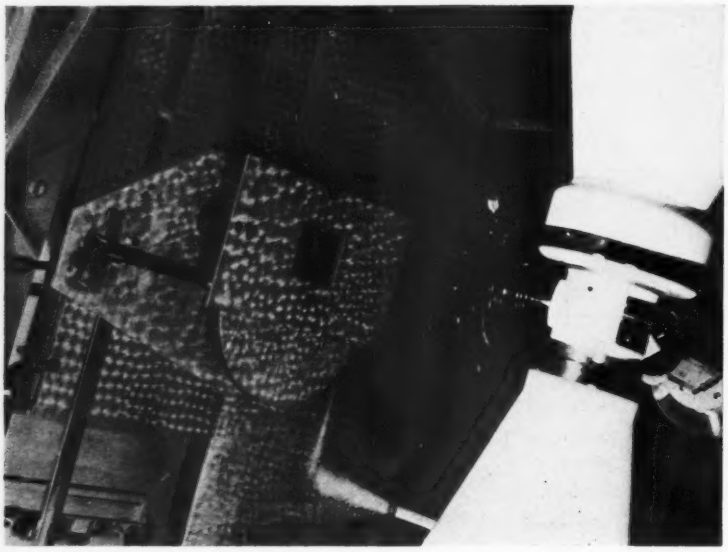

Fig. 2.

been in use in my laboratory for two years, and has been relied on for all the roentgenoscopics and roentgenographics of a busy service; beside this, it has served to record a score of films. Since the new year, I have been using a 2 mm. Philips Rotalix. This tube, like the preceding one, also has been used in registering a score of films, and functions for all the needs of the service without showing any signs of wear. This tube bears a charge of 80 kv.m. with 80 ma. for 25 seconds; for lower tensions I have extended the exposure time up to 35 seconds. Since the tube functions the whole time the pictures are being taken, I have interposed between the subject and the tube a synchronous rotary leaded shutter (Fig. 2), which protects the patient during the displacement of the film. The measurements taken with several ionometers prove that the patient receives only

A few months ago, thanks to the National Fund for Scientific Research, I undertook the construction of a new apparatus for direct roentgen cinematography (Fig. 3); it is an apparatus with separate films which follow in succession at a cinematographic cadence. This apparatus is actually finished, and the first trials have been satisfactory. It was conceived in order to utilize greater active surfaces, permitting me to record more extensive regions; for instance, the bi-renal region during intravenous pyelography, the entire bladder, with urethra, etc. Here I have replaced the jerky movement with a continuous rotary movement. The apparatus contains a magazine filled with separate films perforated at the margin at one extremity of the lower edge of a slit 5 cm. long by 5 mm. wide. These films are superimposed in a magazine with slides at a distance of 3 mm. from one another (Fig. 4). The magazine is brought down gradually by a system of endless screws, resting

[2] The width of 179 mm. was chosen as it is the width at which the film manufacturers cut their 13 × 18 film.

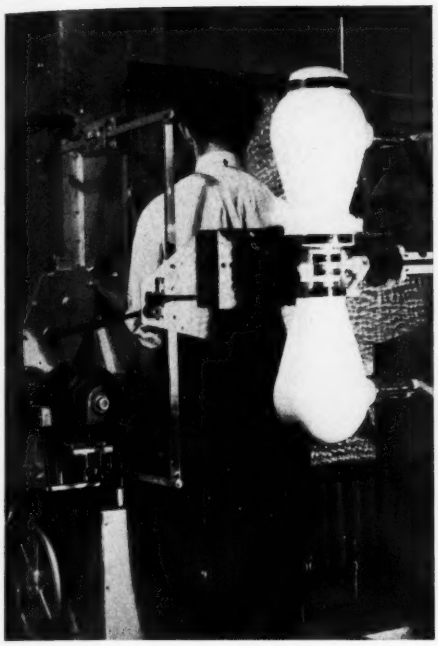

Fig. 3.

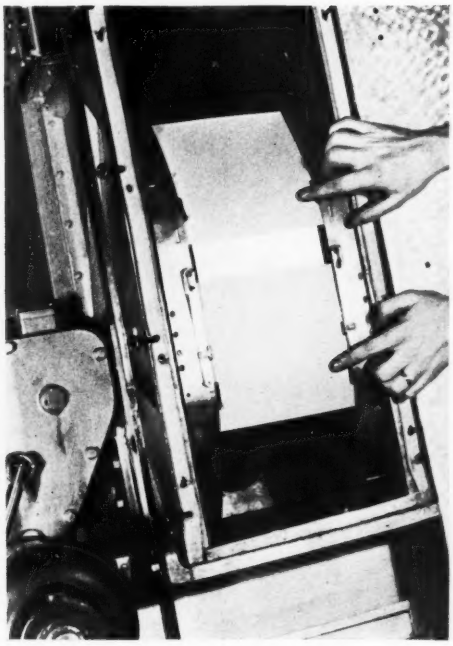

Fig. 4.

on an axis, bearing a primary series of retaining rods which keep the films between the intensifying screens (Fig. 5). At this moment the film is immobilized by a compressor, similar to that of the preceding apparatus during the exposure; then other releasing rods lead it to a receiving magazine (Fig. 6), where a system of hooks insures the release and the piling of the films in a receptacle, which is closed by a sliding cover, after which it is taken to the dark room.

For roentgen cinematography of the cavities of the organs of the human body, the image of which is usually veiled by the oblique and secondary rays, I place before the camera gate and lens a movable, anti-diffusion, rotating grid. The speed of displacement of the rotating grid may be regulated independently from that of the other parts of the apparatus. I use a rotation speed of 240 turns a minute. Since the only movable anti-diffusion appliance that could be fitted to my apparatus was one with continuous rotation, I chose the Siemens rotary model, but in so doing a great difficulty had to be overcome. Indeed, since I could not, for such a short exposure, diminish the area of the image, which was already reduced by registering on it the axis of rotation encircled by some halo, I decentered the anti-diffusor in such a manner that only the most marginal portion possible was used, namely, that with the greatest displacement speed, but with this system I found in the median portion of the image some streaks formed by the lead strips. I decentered the tube a trifle (2°) so that the normal ray should slant slightly toward the periphery; thus, without distorting the image, I avoided the streaks previously mentioned by affording the rays a better passage between the strips of the anti-diffusing grid.

It is evident that with the anti-diffusion grid I do not obtain 16 images a second, when using the potentials which I have specified, and which, while giving a satisfactory return, guarantee at the same time the integrity of the tube. I have obtained

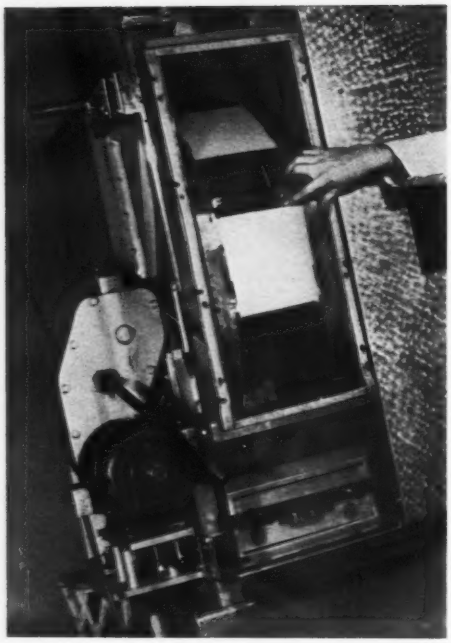

Fig. 5.

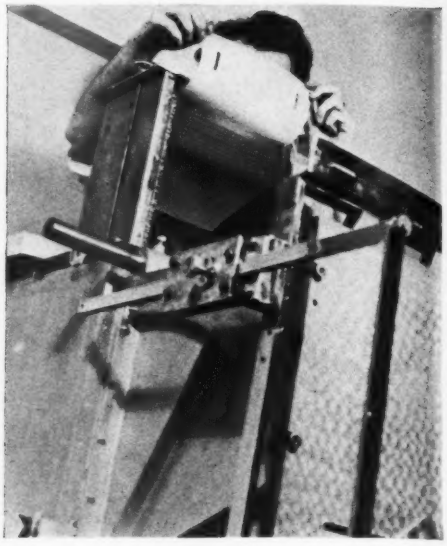

Fig. 6.

six and a half images per second (number of turns according to the turncounter 390). This speed is sufficient to give the exact measure of the real speed of the movements to be studied; it also permits the study of the displacement mechanism.

Each image is doubled or trebled when the standard film is made, so as to reconstitute, according to the speed of the projection apparatus, the unity of movement in unity of time.

II. ADVANTAGES AND DISADVANTAGES OF ROENTGEN CINEMATOGRAPHY

If we wish to give an absolutely objective opinion of the present advantages and disadvantages of the two methods of roentgen cinematography, we may advance the following considerations:

1. Roentgenoscopic Method.—This method has certain undeniable advantages: in the first place, it permits the registration of movement as it appears upon the entire surface of the fluorescent screen (the entire thorax, the neck, the upper extremities, etc.); and then the price of the film is moderate. As disadvantages might be mentioned the lack of clearness in the images, and the impossibility of registering accurately the movements of the deep organs (ureters, bladder, gall bladder, etc.). These defects may be explained by the fact that this method is based upon roentgenoscopy, the drawbacks of which in roentgen diagnosis are well known; furthermore, those faults are now exaggerated because, in order to record the images, the fluorescent screen must be brilliantly illuminated by opening the diaphragm widely, and throwing on the screen a powerful light. It follows that the details of the roentgenoscopic image, which are already insufficient, are lost still more, and that the outlines of the organs become blurred. And beside, these images must be projected a great distance from the screen, at a much accelerated speed, with a wide open objective.

2. The Direct Method.—It also has its disadvantages: in the first place, the higher price of the original film, and then the fact that the film must be transferred to a size suitable for projection. However, the price is not at all prohibitive, and

the transfer is easily made. As advantages we must mention the extreme clearness of the images, the slightest details of which are brought out; furthermore, each image of the original film constitutes an ordinary roentgenographic document which may be studied at leisure.

III. OUTLOOK FOR THE FUTURE

At the Radiologic Congress in Vienna, last September, the great question of roentgen cinematography was the order of the day. There the consensus was, notwithstanding the technical efforts of the last few years, of which the indirect method was the only one to profit, that the method had not made any important progress since the International Congress of Zurich. Practically speaking, the abdominal organs always escape investigation, as might have been foreseen from the shortcomings of roentgenoscopy, upon which the method is based.

The direct method, on the contrary, has already proved the important rôle it is capable of playing, as has been shown by its application to the study of normal and pathologic physiology of the urinary tract (plenary session of the International Congress of Vienna, September, 1936).[3] The revelations that this method has brought to the study of the urinary function can be brought to the study of other organs also: gall bladder, rugæ of the gastric mucous membrane, arteriography, encephalography, etc. Up to the present time, direct roentgen cinematography has not profited by any technical progress, but I expect soon to do away with the obturator by interrupting the emission of the rays, during the displacement of the film; by so doing, the exposure can be doubled without affecting the tube.

This modification will permit the use of tubes with a focus of from 1 to 2 mm., as the necessary changes are weak, and, thanks to the fineness of this focus, the use of the anti-diffusion grid may be discontinued. In closing, let us hope that the tube manufacturers will adapt their tubes to roentgen cinematography. By improving the cooling of the anti-cathodes, they will permit longer exposure or greater intensity, preserving at the same time these tubes for the routine work of the laboratory.

[3] Title of the paper: La radiocinematographie directe du Dr. Van de Maele appliquée à l'étude de la physiologie normale et pathologique des voies urinaires, par le Dr. F. Stobbaerts, urologue à Bruxelles.

RADIOTHERAPY OF BLADDER CARCINOMA: FIVE-YEAR RESULTS: FAILURES: FUTURE THERAPY[1]

By BENJAMIN S. BARRINGER, M.D., Memorial Hospital, *New York City*

THE three-year cures by radium of 215 cases of bladder cancer show 67 cases, or 31.7 per cent. The five-year cures show 52 cases, or 24.1 per cent, a drop of 7.6 per cent. The total number of cases in which the bladder has become cancer-free are 96, or 44.6 per cent.

These cases were treated cystoscopically and by suprapubic implantation.

They include all cases, no matter how extensive, in which the bladder was opened. Radium was implanted in many very extensive carcinomas with the idea of controlling more cases. Notwithstanding this, five-year cures fail in about three-fourths of all cases.

PATHOLOGY OF CURED CASES

Papilloma with atypical cells	5
Papillary carcinoma	14
Infiltrating carcinoma	16
Adenocarcinoma	1
Grade I	10
Grade II	30
Grade III	12
Grade IV	2
No pathology	6
	96

Of these cases, 36 were not graded; 16 cases were infiltrating carcinoma. The 10 cases of Grade I were not papilloma, but were graded according to the Memorial grading; that is, they were papillary carcinoma. In the six cases in which there was no pathology, the diagnosis was made clinically, either because of a sloughing tumor or by induration felt vaginally or rectally.

It is noteworthy that but two Grade IV have been controlled. With proper methods of irradiation, I do not believe that the Grade IV carcinoma should be more difficult to control than the other grades. If the control is by operation alone, of course that is a different matter. As Grade IV bladder carcinomas are relatively rare, it would seem that the percentage of cures is but slightly less than those of other types.

TIME THAT CURED CASES HAVE BEEN WELL

Less than 1 year	9
1 to 2 years	6
2 to 3 years	12
3 to 4 years	12
4 to 5 years	5
5 to 7 years	19
7 to 10 years	19
More than 10 years	13
More than 20 years	1
	96

PATHOLOGY OF DEAD CASES

Papilloma with atypical cells	6
Papillary carcinoma	10
Infiltrating carcinoma	22
Grade I	3
Grade II	20
Grade III	34
Grade IV	10
No pathology	17

All that we can glean from this table is that the infiltrating carcinomas are more difficult to cure than the papillary carcinomas.

TIME UNTIL DEATH OF UNCONTROLLED CASES

Less than 1 year	66
1 to 2 years	29
2 to 3 years	11
3 to 4 years	4
4 to 5 years	4
5 to 7 years	5
7 to 10 years	1
More than 10 years	1

Most patients die in the first year and the reason for this first-year death rate is unquestionably severe infection of the bladder and kidneys. Probably but few of those who die in the first year, actually die of carcinoma.

Multiplicity of Tumors (96 Cases).—The Carcinoma Registry has emphasized that bladder cancers are more often multiple than single. They have even seen fit to change the pathological diagnosis from papilloma to carcinoma on the clinical basis that carcinomas are multiple. Unquestionably from the clinical stand-

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

point the fact that there are several tumors instead of one indicates in a broader sense that multiplicity of tumors constitutes a malignant element as compared to singularity of tumors. On the other hand, from my records bladder carcinomas are usually single. The following table emphasizes this:

CONTROLLED CASES	
Single	73
Multiple	23
UNCONTROLLED CASES	
Single	86
Multiple	35
CARCINOMA REGISTRY GRADED CASES	
Controlled cases	47
Uncontrolled cases	66

FACTORS INFLUENCING TYPE OF THERAPY

(A) *Size of Tumor.*—Small tumors, papillary or infiltrating, are best treated cystoscopically by radon seeds implanted or radon applications. Large tumors, if papillary, are treated by suprapubic radon implants. Large tumors, if infiltrating, are treated by methods outlined below.

(B) *Grade of Tumors.*—Lower grades of malignancy (I and II) are treated as above outlined. Higher grades of malignancy, particularly Grade IV, are treated, if possible, by external irradiation and cystoscopy.

(C) *Position of Tumors.*—When tumors of the bladder base (75 per cent of all bladder tumors) are encroaching upon the ureters or internal urethra, radiation therapy is superior to operative removal.

(D) *Condition of Kidneys.*—If the kidneys are infected, the ureters and kidney pelves dilated, then cystoscopic treatment by radium is superior to the open operation. The suprapubic operation and the massive implantation of radon seeds add to the infection. The implantation or application of radium cystoscopically can be done in divided treatments.

Comparison between Surgical and Radiation Results.—Probably the best surgical five-year results in bladder cancer are 25 per cent controls. These surgical results are computed on the total number of cases in which the tumor could be removed surgically. Obviously there are a large number of cases in which surgical intervention is impossible, and which the surgical statistics do not include. Our radiation statistics include all cases in which the cancer is believed to be confined to the bladder. The size of the carcinoma has not prevented an attempt to cure it. The radiation results, if we can report 24 per cent five-year cures, must obviously be better than the surgical results.

Disadvantage of Radium Treatment.—The implantation of seeds into an infected tumor increases the amount of infection present. A slough is always formed and this presents a focus of increased infection. This slough may become incrusted with calcareous deposits and stone formation may result. Asepsis and a certain amount of antisepsis helps obviate this condition. Cleansing of the bladder with antiseptic washes before and after cystoscopic implantation, extreme care in the suprapubic approach, and painting of the tumor base with mild solutions of iodine before radium implantation all help. If the tumor is badly infected, however, nothing will prevent severe infection and cystitis and bilateral pyelonephritis.

Vesico-vaginal fistula in female patients occurs. I have had three such in the above series: one is dead; one lived five years and then died of an acute kidney flareup; one has gone about two years and is reasonably comfortable after a skin implantation of the dilated ureter of her single kidney.

Suprapubic versus Cystoscopic Radiation.—Not only the size of the tumor but the infection of the tumor and the condition of the kidneys should determine the method of treatment, whether suprapubic or cystoscopic. We are steadily leaning more and more toward the cystoscopic treatment. If the tumor is ulcerated and infected and if the kidneys are hydronephrotic, the suprapubic implantation of a large amount of radon is a dangerous procedure from the infection standpoint.

VARIOUS FORMS OF RADIATION IN USE

I. *Radon Seeds.*—These have constituted the best method for both suprapubic and cystoscopic application of radium.

II. *X-ray Alone.*—Much has been written of late about the control of bladder cancers by x-ray alone. Notwithstanding repeated and persistent attempts on our part to control the more difficult types of bladder cancer, deep x-ray therapy has signally failed. The reports of cases so treated have been singularly inadequate, both as to pathology, time of cure, and the failure in at least one such report to mention the essential fact that radium was an adjunct to the x-ray treatment. The use of x-ray in the milder forms of bladder cancer or in papilloma, which could easily be controlled by cystoscopic fulguration or radium application, is, to me, unjustifiable. I have seen, after prolonged x-ray irradiation, extremely severe effects, and I have seen two patients die from skin destruction after such irradiation. In one of these an infiltrating tumor had been controlled and the bladder was tumor-free. Most bladder cancers are quite radio-insensitive. As we at present know how to handle deep x-ray therapy, it is not alone sufficient: it might perfectly well be used as an adjunct to operation or to radium in the higher forms of malignancy, particularly Grade IV.

III. *X-ray plus Radon Seeds.*—I have attempted in three cases of ulcerated extensive infiltrating carcinoma to combine these two, the radium applied either cystoscopically or suprapubicly. These three patients have all succumbed.

IV. *Fulguration.*—The statistics of Braasch still constitute the only series in which a small number of infiltrating tumors have been controlled by fulguration.

V. *Fulguration and X-ray.*—Considerable work has been done lately with the instrument used for transurethral prostatectomy in fulgurating extensive bladder tumors, followed by x-ray therapy. No extensive series, so far as I know, has been reported. It would seem that fulguration does not work as an adjunct to x-ray, as does radium.

VI. *Pre- or Post-operative X-ray Irradiation.*—Theoretically either of these procedures might so partially devitalize tumor cells that the operative removal might result in a larger number of cures. I believe that to be more a theoretical than a practical consideration. At any rate, I have not seen any reported series to substantiate this.

VII. *Radium Application.*—The application of a large amount of radium, held against a tumor for periods of one hour each by means of the cystoscope and under direct vision, might seem the answer to the control of more cases of large ulcerating bladder cancers, which are virtually beyond our grasp at present. We have several such cases which we will report later in which this method has been effective, particularly as used in conjunction with mild deep x-ray therapy. The infection in the bladder would seem to be less than when radon seeds are implanted and the suprapubic operation is omitted. Only further work can determine, however, whether we will be able to extend the number of five-year controls of bladder carcinoma.

CASE REPORTS AND NEW DEVICES

A REFLECTING PHOTOELECTRIC ERYTHEMA EVALUATOR

A PRELIMINARY REPORT

By O. R. TROJE, M.D., *Fairfield, Alabama*

Spectrophotometric color analysis is, of course, not new and is said to have been first used by Sheard and Sanford, of the Mayo Clinic, in 1928, for hemoglobin estimations. Their method was possibly an adaptation from the industrial field to the clinical laboratory, while mine is merely an attempt to make practical use of the same principle in the radiological field. Each method, of course, has its obstacles, the most important of which is the production of an unvarying base current and voltage *i.e.*, wattage. Perfection in this is obviously impossible, but the storage battery when in good condition and freshly charged gets close enough for practical purposes. It may have a potentiometer across one of the end cells. Other solutions would be the constant wattage transformer or some of the V. T. voltage regulating devices now on the market.

The principle of operation depends entirely on the current fluctuation produced in a barrier plane type photoelectric cell by the variations in intensity of luminosity striking its surface, due to the variations in skin shade or complexion which are reflected into the photoelectric cell by an especially designed illuminator. The fluctuation is read off on a microampere meter properly inserted in the circuit. At present, I am still using a 0 to 1 milliampere meter with 5,000 ohms in series with the P.E. cell, and an ordinary Pese Magnicell. By improving the quality of my units and increasing the resistances I will be able to get a response to much narrower dif-

WIRING DIAGRAM

A REFLECTING PHOTOELECTRIC ERYTHEMA EVALUATOR

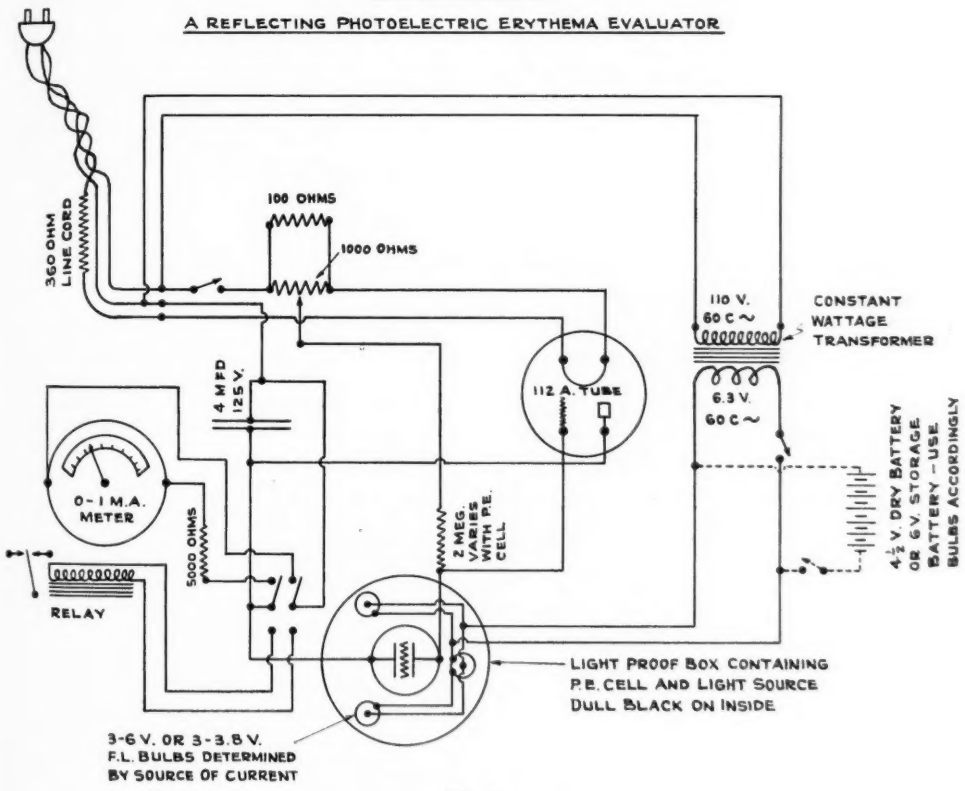
360 OHM LINE CORD
100 OHMS
1000 OHMS
4 MFD 125 V.
0-1 M.A. METER
5000 OHMS
RELAY
2 MEG. VARIES WITH P.E. CELL
112 A. TUBE
110 V. 60 C ~
CONSTANT WATTAGE TRANSFORMER
6.3 V. 60 C ~
4½ V. DRY BATTERY OR 6 V. STORAGE BATTERY - USE BULBS ACCORDINGLY
LIGHT PROOF BOX CONTAINING P.E. CELL AND LIGHT SOURCE DULL BLACK ON INSIDE
3-6 V. OR 3-3.8 V. F.L. BULBS DETERMINED BY SOURCE OF CURRENT

Fig. 1.

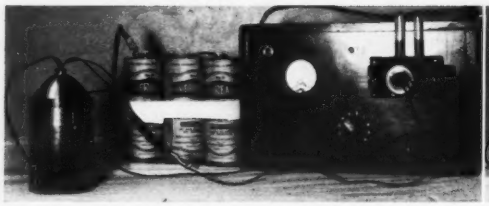

Fig 2.

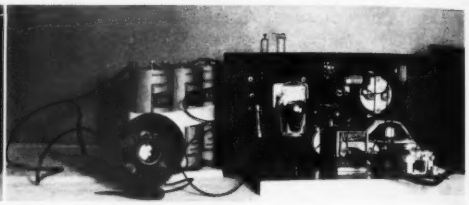

Fig. 3.

ferences in shading, even though slowing down that response. This is of no consequence in this instance as we do not require the instantaneous action so necessary to the proper functioning of other photoelectric devices: *e.g.*, television, relays, etc. We are interested only in accurate needle deflection, and a few seconds lost in obtaining this necessary accuracy is unimportant.

The wiring diagram (Fig. 1) is the one used in the instrument first constructed. It is undergoing almost daily alterations for obvious reasons.

The illuminator must be finished a dull black inside and the bulbs should be frosted or color filters used. The sensitivity of response seems to be greater when working with as little illumination as possible. The light source must be well back of the P.E. cell and preferably multiple. In my instrument I am using three 3.8 v. flashlight bulbs.

The hook-up is a modification of the Pese Universal Photoelectric set. I have retained the sensitive relay in order to test the P. E. cell and to demonstrate it to my colleagues. It also serves to protect the ma. meter, for the full output of the cell even through a 5,000 ohm series resistance would be too much current and might injure the ma. meter. A double pole double throw switch is used to cut in or out either the relay or the meter, and the switch is always left on the relay side after use.

OPERATION

We first established a zero or starting response. For this purpose the abdomen of a young blond female was used. The meter was set arbitrarily at 0.5 ma. It is to be understood that this figure has no meaning or value in itself, but only when compared with other subsequent readings on the *same* individual, or other primary readings, or "zeros" obtained from the *natural* complexions of other individuals. The light source in the illuminator is then turned on and the deflection of the needle noted. This happened to be to 0.720 ma., or a deflection of 0.220. This experiment was repeated a number of times and was always

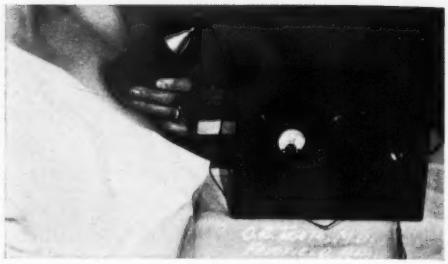

Fig. 4.

the same except when line voltage fluctuations occurred. This made it necessary to re-design the voltage supply, more of which in a later report. Next, a much darker complexioned individual was taken and a reading of 0.660 obtained, showing that the intensity of reflected luminosity was less in this individual. Other experiments with ultra-violet light erythema estimations have been and still are being carried out. While much still remains to be done, I have gone far enough in this thing to believe that variation in erythema can be determined with more consistency by the P.E. cell than by depending on the human eye and with a degree of accuracy well within practical limits. Thus standards of erythema could be established for different values of $(\lambda + r)$ and supplied in proper form with each instrument; also several standards of normal complexions could be determined in the same way. The light and color response of the P.E. cells would be checked against a standard so that each instrument could be adjusted by the user for zero, threshold erythema, and so on, with the necessary accuracy.

I believe there is a possibility that an instrument of this kind can be produced which will fulfill the desire of many for a biological unit or the statement of x-ray dosage in terms of erythema.

As previously stated, there are many problems to be solved, but I believe they are of a minor nature.

Figures 2 and 3 show the unit in and out of the cabinet; Figure 4 the unit in use on a pa-

tient, establishing a "zero" on the skin of her as yet unirradiated breast.

In closing, let me say that while I hope this idea has some originality and merit I make no claims of any kind, but am offering this preliminary report more for the purpose of calling it to the attention of others better qualified than myself. They can judge whether or not this apparatus has possibilities and if the so-called erythema dose of to-day could, by eliminating the personal equation, be given a real meaning.

ANCIENT ARTHRITIS

By E. BURNHAM CHAMBERLAIN, Curator of Mammals, Charleston Museum
and
ROBERT B. TAFT, M.D., *Charleston, South Carolina*

While it is well known that arthritis is a very old disease, having been found in the skeletons of ancient man, the finding of evidence of this disease in what may well be called the shadowy past seems worthy of note.

In October, 1937, the Charleston Museum received two large molar teeth dug up on John's Island, near Charleston, S. C. The digging of a boat slip on the edge of a salt water creek had brought to light a number of fragments of bone, some molar teeth, and parts of tusks. Investigation and subsequent excavation disclosed a deposit of broken bones and a few molars of a mastodon, *Mammut sp.*, lying on the creek edge near the low water mark, and at a depth of approximately six feet. The fossiliferous layer is composed of silt with considerable vegetable matter present; above this bed is a three-foot stratum of hard sand, this in turn being topped with about three feet of marsh-bearing mud. The bones of this deposit were so soft that removal proved difficult. That the animal was an old adult is evidenced by the worn condition of the molars; its age is placed as late as, if not post-, Pleistocene.

The fossil elephants, both mastodons and mammoths, were widely distributed both in time and space; the former known from the mid-Miocene (about ten million) to the end of the Pliocene (about one to six million) years ago, in the Old World, and until the late Pleistocene in America. The Pleistocene period is considered by geologists to have covered from ten thousand to one million years. Remains have been found in Europe, Asia, and North America. Certain it is that early man knew these huge animals, and there is ample evidence of their contemporary existence, at least in the Old World. Now it appears that early man and the mastodon had more in common than mere acquaintanceship, as this particular beast

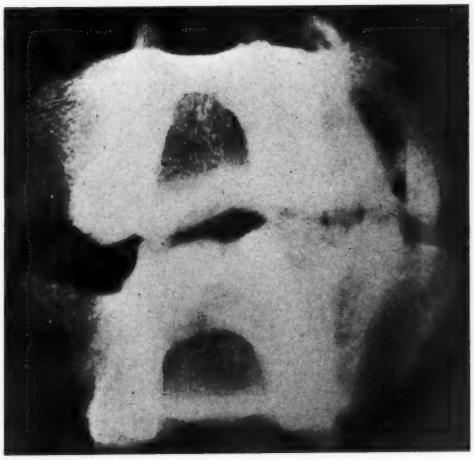

Fig. 1.

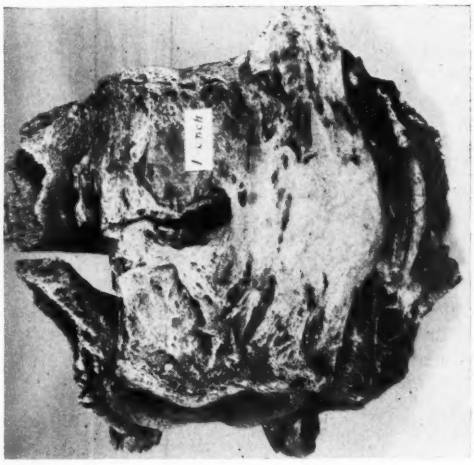

Fig. 2.

suffered from osteo-arthritis of the same type seen by every radiologist to-day.

In excavating some of the above-mentioned material, we uncovered two thoracic vertebræ lying together as if in their original position. On removing the surrounding mud and sand, we found that these vertebræ were connected by a broad band of bone between their ventral surfaces. A radiograph (Fig. 1) showed this connecting band definitely to be of bone, eliminating all reasonable doubt as to the diagnosis. The splintered appearance is probably due to the drying out after removal from the mud. The photograph (Fig. 2) shows the specimen in the same position as seen in the radiograph. Several of the ribs showed heavy proliferation of the cortex. Many other fragments of the skeleton show similar changes though to a lesser

degree. It seems at least possible that these bony changes were so extensive that proper movement of the skeleton was interfered with, making the animal fall easy prey to one of the many large carnivora that abounded at the time.

A CASE OF SEVERE INJURY TO CHEST WALL AND DIAPHRAGM

By E. W. ROWE, M.D., *Lincoln, Nebraska*

Patient C. S., male, 24 years of age; occupation, student.

Final Diagnosis.—Contusion of chest wall, followed by (1) emphysema of the chest wall; (2) hemorrhage, subdiaphragmatic, and (3) secondary hemorrhage, intra-pleural.

History.—While at work on an auditorium stage at 11:45 A.M., on March 25, 1937, the patient lost his balance and fell backward from an 18-foot ladder. About eight feet from the floor he struck a painter's jack with the right side of his chest. This was a steel bar one-half by one and one-half inches, and the force of the impact was sufficient to bend it to an acute angle. This blow whirled the patient around so that he landed on his feet and then toppled backward, the ladder falling over his legs. Immediately he experienced considerable pain over the seventh to ninth ribs in the right axilla and in the back at the same level. He could feel crepitation in the axillary soft tissues and in the back. He was immediately given a quarter grain of morphine sulphate and sent to the hospital by ambulance.

Past History.—Two years before, in football, he fractured two ribs on the left side. General health was good, and he participated in school athletics.

Family History.—Not remarkable.

Physical Examination.—Thorax: large, swollen, discolored area about eight inches in diameter centering over the seventh or eighth rib in the right axillary line. The tissue crepitated on palpation. Resistance below right costal region and elevation of diaphragm noted. Respiration painful but aeration of the right lung normal except that the diaphragm was high and immobile (Figs. 1 and 2).

Pulse, 52; temperature, 98.6°; respiration, 18; hemoglobin, 105 per cent; white blood cells, 22,240 (March 26, 1937).

Clinical Course.—Second day: temperature, 100.8°; pulse, 100; respiration, 30. Sixth day: temperature, 98.6°; pulse, 80; respiration, 18. Patient left hospital with some tenderness in right side but fairly comfortable.

He was examined frequently after leaving the hospital. These examinations revealed a lowering of the diaphragm and lessening of the subdiaphragmatic dullness. Patient was comfortable, keeping to his bed most of the day under protest. On April 21, 1937, after an x-ray examination, he had distressingly sharp pains around the region of the umbilicus. These continued and then partially subsided after five or six days; increased again, with elevation of temperature in afternoons, and with respiratory embarrassment.

The patient was re-admitted to the hospital on April 26, 1937. His roentgen examination was as shown in Figure 3. Temperature, 100°;

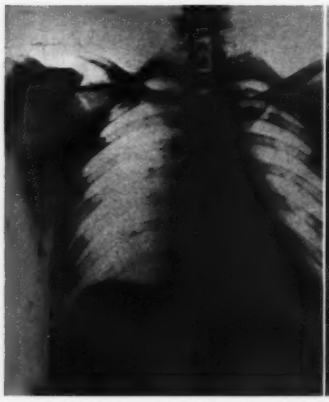

Fig. 1. Examination made immediately after the injury shows (1) emphysema in the soft tissue overlying the right side of thorax; (2) lungs negative; heart not remarkable.

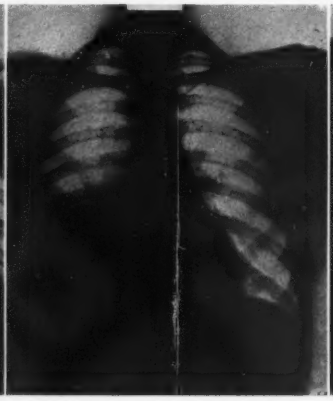

Fig. 2. Decrease of air in soft tissue of the chest wall; sub-diaphragmatic hemorrhage (March 27, 1937).

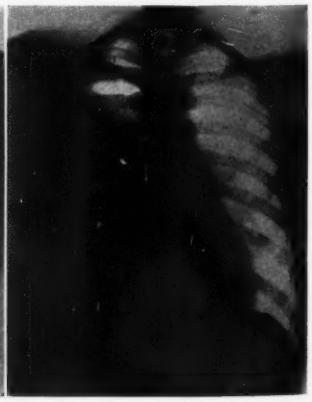

Fig. 3. Sudden onset of pain in right chest, dyspnea and cough (April 26, 1937). Right pleural sac filled with blood, proven by paracentesis; collapse of lower middle, and most of upper lobe.

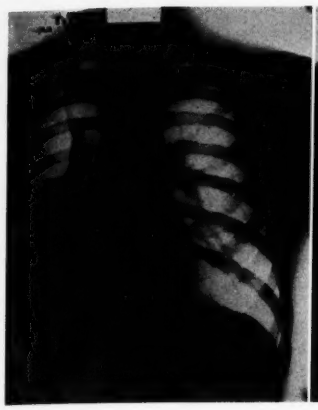

Fig. 4. Hydro-pneumothorax; lung expanded slightly; fluid on shelf-like projections of pleura (May 1, 1937).

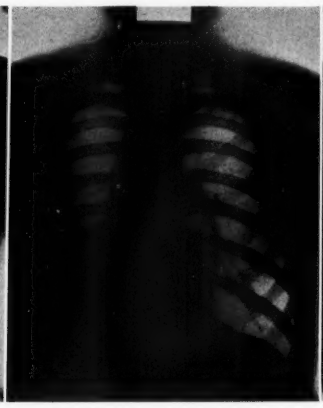

Fig. 5. Almost complete expansion of the middle and upper lobes; slight amount of fluid in the pleural sac (May 26, 1937).

Fig. 6. Right lung fully expanded except for some limitation of the diaphragm; no fluid; patient in good health (June 11, 1937).

pulse, 90; respiration, 20. These became normal. Bloody fluid was withdrawn on several occasions by paracentesis; 2,660 c.c. was recorded, and replaced by a smaller amount of air. No organisms were found. Smear and culture were repeated. Bloody fluid became a transudate after paracentesis. Gradual return of the right chest to nearly normal condition. Roentgen examination was recorded in films reproduced as Figures 4, 5, and 6.

The patient was discharged from the hospital on May 5, 1937, improved. He continued to rest at home for several weeks. His recovery is complete at the present writing (Aug. 10, 1937).

SUMMARY

The above findings are brief conclusions based on the clinical record and the study of the roentgen examinations at different intervals. It is quite evident that at the time of the accident there was severe injury to the right chest wall and diaphragm. Under great pressure a quantity of air was forced from the lung into the chest wall, but the lung and pleura closed after the escape of air. Blood slowly accumulated beneath the right diaphragm, causing the elevation. Improvement was taking place, with absorption of the blood and return of the diaphragm to normal. Suddenly, one month later, a severe hemorrhage occurred, filling the right pleural cavity and collapsing the lung, accompanied by much shock. After paracentesis, repeated several times, the lung expanded and the remaining fluid was subsequently absorbed. There has been almost complete return to normal in the function of the lung, pleura, and diaphragm.

This case is unusual in that (1) emphysema occurred in the chest wall without collapse of the lung; that (2) hemorrhage into the pleural cavity took place a month later, and (3) full recovery has followed.

OBJECT RECONSTRUCTION BY PLANIGRAPHY: RECONSTRUCTION AND LOCALIZATION OF PLANES

By JULIUS KAUFMAN, M.D., *Brooklyn, N. Y.*

Any object may be considered the integration of its constituent, serially juxtaposed, parallel planes. By planigraphy (1, 2) it is possible to delineate from two or more radiographs all the plane images of an object, to determine their depths, and finally to reconstruct the actual planes. By relocating the reconstructed planes (plane localization) in their relative positions in space, it is possible to reconstruct the object radiographed.

The manner in which plane images are delineated and their depths determined has previously been described (1). The author's method of plane reconstruction (2), however, did not include plane localization. Since it is necessary to localize planes, as well as reconstruct them, to accomplish object reconstruction, the previous method of plane reconstruction falls short of the goal desired. To accomplish this we found it necessary to evolve an original, simple, graphic procedure which not only accomplishes plane reconstruction, but plane localization as well.

In Figure 1, image $A.1$-$B.1$-$C.1$ represents the plane image (obtained by planigraphy,[1]) of

an arbitrary plane, *A-B-C*, of an object (object not shown in figure), depth *h* above the plane of the film. The problem involved is the

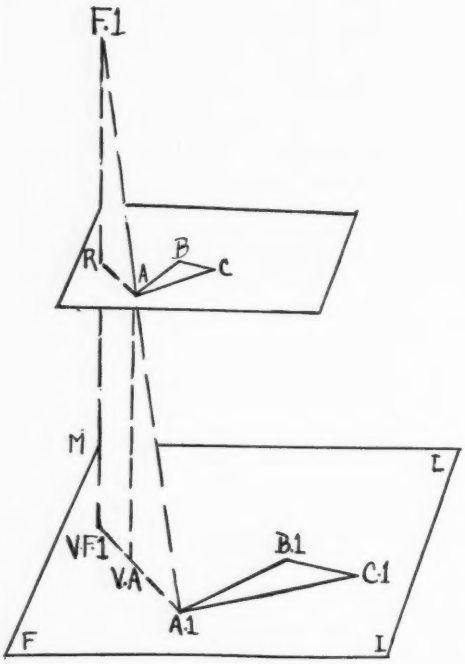

Fig. 1.

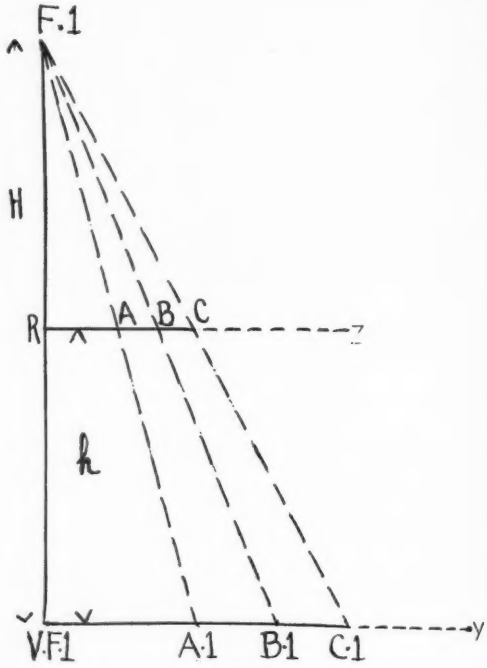

Fig. 2.

reconstruction of figure *A-B-C* from its image, *A*.1-*B*.1-*C*.1, and the relocation of this reconstructed plane, so that it bears the same position in space as the original plane.

Point *F*.1 represents the target position, height *H* above the plate (*F.I.L.M*). Point *V.F*.1 represents the vertical projection of *F*.1, ray *V.F*.1-*F*.1 being a perpendicular (or central) ray. Distance *R-A* (radius vector) represents the distance separating point *A* from central ray *V.F*.1-*F*.1. Line *V.F*.1-*A*.1 represents the image of radius vector, *R-A* (radius vector image). Point *V.A*, represents the vertical projection of point *A*. Point *V.A*. lies along the radius vector image (*V.F*.1-*A*.1) at a distance from *V.F*.1 equal to the radius vector (*V.F*.1-*V.A*. = *R-A*).

The vertical projection of a point in space, accordingly, may be represented on the radiograph by finding its radius vector distance (*R-A*), and by measuring this distance along the radius vector image as depicted on the radiograph.

Radius vector distances may be determined from radiographs by the following simple construction (Fig. 2):

(1) Line *V.F*.1—*Y* is drawn upon a sheet of paper.

(2) Vector image *V.F*.1-*A*.1 is measured on the radiograph, and transcribed to the sheet along line *V.F*.1—*Y*.

(3) *V.F*.1-*F*.1 is drawn perpendicular to *V.F*.1—*Y* and equal to *H* (target-film distance).

(4) *R*—*Z* is drawn perpendicular to *V.F*.1—*F*.1, height *h* (plane-film distance) above *V.F*.1—*Y*.

(5) Points *A*.1 and *F*.1 are joined.

(6) Line *A*.1-*F*.1 intersects *R*—*Z* in *A*.

(7) Distance *R*—*A* represents the radius vector distance sought (compare Fig. 2 with Fig. 1).

The vertical projection, *V.A*, of point *A* is then located on the radiograph in the manner indicated above.

In the same manner the vertical projections of points *B* and *C* are obtained. The vertical projections, so determined are then joined by appropriate lines, thus delineating the reconstructed plane (proof omitted).

By elevating a transcription of the reconstructed plane the distance, *h*, the plane is relocated (localized) in its proper position in space.

In a like manner, other planes of the object

are reconstructed and transcriptions relocated in space, so that when a sufficient number have been so reconstructed, and localized, they may be said to represent the actual reconstruction of the object radiographed.

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(1) KAUFMAN, JULIUS: Planigraphy, Localization and Mensuration: "Standard Depth Curves." RADIOLOGY, August, 1936, **27,** 168.

(2) Idem: The Planigram. RADIOLOGY, December, 1936, **27,** 732.

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary,* Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section.—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president,* E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary,* Merl L. Pindell, M.D., 678 South Ferris Ave. *Treasurer,* Henry Snure, M.D., 1414 Hope Street Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club.—Chairman, Raymond G. Taylor, M.D., 1212 Shatto St., Los Angeles; *Secretary,* L. Henry Garland, M.D., 450 Sutter St., San Francisco.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president* Sanford Withers, M.D., 304 Republic Bldg.; *Secretary,* Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Kenneth K. Kinney, M.D., 29 North Street, Willimantic; *Vice-chairman,* Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida State Radiological Society.—President, Gerald Raap, M.D., 168 S. E. First St., Miami; *Vice-president,* H. O. Brown, M.D., 404 First Nat'l Bank Bldg., Tampa; *Secretary-Treasurer,* H. B. McEuen, M.D., 126 W. Adams St., Jacksonville.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* William F. Lake, M. D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president,* Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer,* Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802-Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology.—President, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa; *Secretary,* Ralph G. Willy, M.D., 1138 N. Leavitt St., Chicago.

INDIANA

Indiana Roentgen Society.—President, J. N. Collins, M.D., 23 E. Ohio St., Indianapolis; *President-elect,* Stanley Clark, M.D., 108 N. Main St., South Bend; *Vice-president,* Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary,* H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president,*

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

Michigan Association of Roentgenologists.—President, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

MINNESOTA

Minnesota Radiological Society.—President, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

Nebraska Radiological Society.—President, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society

NEW JERSEY

Radiological Society of New Jersey.—President, J. D. Tidaback, M.D., 382 Springfield, Summit; *Vice-president*, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Secretary*, P. S. Avery, M.D., 546 Central Ave., Bound Brook. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, John Barnes, M.D., 875 Lafayette Ave.; *Vice-president*, W. L. Mattick, M.D., 290 Highland Drive; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, David E. Ehrlich, M.D., 27 W. 86th St., New York City; *Vice-president*, H. Koiransky, M.D., 43–37 47th St., Long Island City; *Secretary*, S. Schenck, M.D., 115 Eastern Parkway, Brooklyn; *Treasurer*, Moses Goodman, M.D., 45–01 Skillman Ave., Long Island City. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, E. F. Merrill, M.D., 30 W. 59th St., New York City; *Vice-president*, I. W. Lewis, M.D.; *Secretary*, H. K. Taylor, M.D., 667 Madison Ave., New York City; *Treasurer*, R. D. Duckworth, M.D., 170 Maple Ave., White Plains. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

Society of Radiological Economics of New York.—President, Albert L. Voltz, M.D., 115–120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president*, John Heberding, M.D., St. Eliza-

beth's Hospital, Youngstown; *Secretary-Treasurer*, Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, George Benzing, M.D., St. Elizabeth Hospital, Covington, Ky.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—*President*, Sydney J. Hawley, M.D., Geisinger Memorial Hospital, Danville; *First Vice-president*, William J. McGregor, M.D., 744 Franklin Ave., Wilkinsburg; *Second Vice-president*, Oscar M. Weaver, M.D., 12 S. Main St., Lewistown; *Secretary-Treasurer*, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Charles S. Caldwell, M.D., 520 S. Aiken Ave., Pittsburgh. Annual meeting, May, 1938. Exact date and place to be decided.

Philadelphia Roentgen Ray Society.—*President*, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president*, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary*, Barton H. Young, M.D., Temple University Hospital; *Treasurer*, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—*President*, F. L. Schumacher, M.D., Jenkins Arcade; *Secretary*, H. N. Mawhinney, M.D., Mercy Hospital. Two Fall and two Spring meetings at time and place designated by president.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—*President*, Robert B Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer*, Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—*President*, H. S. Shoulders, M.D., 246 Doctors Bldg., Nashville; *Vice-president*, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—*President*, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect*, Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president*, C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president*, M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer*, G. D. Carlson M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—*President*, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

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Washington State Radiological Society.—*President*, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—*Secretary*, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

Radiological Section of the Wisconsin State Medical Society.—*Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE DILEMMA OF PROPHYLACTIC POST-OPERATIVE IRRADIATION IN MAMMARY CANCER

The value of post-operative irradiation in the treatment of cancer of the breast is a subject of great interest not only to surgeons and radiologists but to physicians in all phases of medicine. The differences of opinion upon this subject, however, among leading authorities leave this problem in a state of confusion, and few medical meetings on irradiation of cancer fail to evoke a lively discussion upon this question. In the light of these circumstances, it may be helpful to re-examine the facts critically, to analyze some of the chief difficulties, and attempt to arrive at a reasonable method of procedure.

Post-operative irradiation has to be considered under two headings: (1) Prevention of local recurrences, and (2) increased curability. Some investigators believe that post-operative irradiation prevents or delays local recurrence after operation, while others believe it has no definite effect upon the local reappearance of the disease. The appearance of local recurrences in the face of intensive irradiation is the most important evidence against the routine use of this method after surgical operation. Intensive prophylactic post-operative irradiation may not only fail to prevent local recurrences, but so injure the skin that adequate irradiation of future recurrences becomes difficult or impossible. It is on this basis that one school of radiotherapists prefers to await the appearance of local recurrence and treat such areas. Another school chooses to irradiate the operative field before the appearance of clinical evidence of recurrence on the basis that microscopic foci are more easily controlled than foci which have become so advanced as to give clinical evidence of their presence.

The effect of prophylactic post-operative irradiation on the percentage of cures involves statistical comparison between cases treated by operation alone and those treated by the combined method. The statistics of the last six or seven years are somewhat more consistent and uniform than those previously reported. A critical review of these data indicates an average of about 30 per cent five-year cures claimed for surgery alone and about 40 per cent five-year cures claimed for a combination of surgery and post-operative irradiation. The most reliable, recent statistics show a remarkable agreement on these figures. It is this finding which must form the basis of a decision upon the indications for post-operative irradiation in any given case of mammary cancer.

The probable accuracy of these statistics is supported by certain known facts concerning cancer of the breast. In the overwhelming majority of cases, death from mammary cancer is due to distant metastases and not to local recurrence. Upon this large group of cases, prophylactic post-operative irradiation obviously can have no effect. The only cases in which this procedure could possibly influence curability is that small group in which death results from local recurrence itself, directly or indirectly. In this connection it is necessary to re-emphasize that when a radical operation is performed upon an operable carcinoma, the patient does not die of local recurrence but of distant metastases.

Under what conditions does local recurrence follow operation for cancer of the breast? Local recurrence appears when, for one reason or another, the operation has not been complete, or the local disease has been more extensive than it appeared from clinical examination to be. The latter condition includes those highly malignant carcinomas which permeate the subdermal lymphatics widely. It would seem logical, therefore, to administer post-operative irradiation to those cases in which the evidence indicates that the disease in all probability extends locally beyond the limits of the operation.

Practically, the cases may be divided into three groups:

(1) Those in which post-operative irradia-

tion is clearly not indicated. An example of this group is a small, localized, definitely operable carcinoma treated by the radical surgical operation in which the clinical findings, operative findings, and pathologic examination combined to indicate that the local disease has, in all probability, been removed. If the axillary lymph nodes are not involved microscopically, this supposition is greatly strengthened. Even in the presence of microscopically involved lymph nodes, however, local recurrence in the axilla almost never occurs following complete axillary dissection when the lymph nodes are small, movable, and have not extended to the apex of the axilla.

(2) Cases in which prophylactic post-operative irradiation is clearly indicated. Examples are cases in which the operation has been inadequate, or in which the completeness of the operation is in doubt, also cases in which the lesion was considered to be operable and found at operation to have been inoperable, or cases in which clinical and pathological evidence indicate that the carcinoma is of the type which has a tendency to wide subdermal lymphatic permeation.

(3) A borderline group in which the treatment of each case has to be decided upon its own merits, taking into consideration all factors including the age of the patient, her general condition, and co-existing disease.

The question naturally arises as to whether, instead of attempting to select the cases in which post-operative irradiation therapy is indicated, it may not be safer to treat the entire group. The argument against this attitude may be stated as follows: A complete cycle of prophylactic post-operative irradiation with adequate doses cannot be regarded as an entirely harmless procedure. The age of the patient and complicating diseases must be taken into consideration. Thus, if a radical operation has been performed upon a strictly operable and localized carcinoma of the breast and the axillary lymph nodes are found to be free of metastasis microscopically, and the patient is either very old or suffering from one of the constitutional diseases, post-operative irradiation is clearly contra-indicated for the chances of local recurrence under these conditions are so slight and the increased chances of cure so small that it does not seem reasonable to risk upsetting the patient's general condition for these indefinite and limited advantages. It seems more logical to weigh the opposing factors in each case before a decision is made and ask the question whether the chances of local recurrence and increased curability as indicated by the clinical and pathological evidence are greater than the risk involved.

MAX CUTLER, M.D.

21 West Elm Street, Chicago, Illinois

ANNOUNCEMENTS

NEXT ANNUAL MEETING

The meeting, as already announced, will be held at Pittsburgh, Pennsylvania, in the Hotel William Penn, from Sunday, November 27, through Friday, December 2, 1938.

The usual routine of the Scientific Sessions will be varied somewhat this year from that of recent years. The morning sessions will be held in the Main Assembly Hall and will consist of papers on general subjects, as usual. In the afternoons there will be two sessions, running simultaneously in two rooms, devoted to Diagnosis and Therapy, respectively. The afternoon sessions will be devoted exclusively to symposia under the leadership of ten outstanding radiologists.

Following the afternoon Scientific Sessions there will be a series of one-hour clinics on various subjects. In some instances these will supplement the papers given in the general sessions where the time is necessarily limited.

An innovation this year will be the so-called "Refresher Courses" which are intended to thoroughly review the fundamentals of certain subjects by men of national reputation along these lines. These will be under the direction of the Publicity and Educational Committee of which Lewis G. Allen, M.D., is chairman. Further details of these will be given in a later issue.

Those desiring to present contributions for the general program should get in touch with the Program Committee.

AMERICAN RADIUM SOCIETY

The Thirty-third Annual Meeting of the American Radium Society will be held in San Francisco, June 13–14, 1938. Headquarters for the meeting, the dinner, and the Janeway Lecture will be at the Clift Hotel, Geary and Taylor Streets.

AMERICAN SOCIETY OF X-RAY TECHNICIANS

The Thirteenth Annual Meeting of the American Society of X-ray Technicians will be held June 28 to July 1, 1938, at Madison, Wisconsin. Headquarters at the Hotel Loraine. The golf tournament will take place on June 27.

COMMUNICATION

WRITE TO YOUR EDITOR

RADIOLOGY will never be a newspaper, we trust; however, an exchange of news items has its desirable features. If a radiologist in your part of the country is trying out something new which he is ready to share with his associates, RADIOLOGY will be glad to hear about his method or findings; if there is an institution organized along new lines, RADIOLOGY will be glad to hear about it. Extend this idea in your own minds. You want to read about advances, so send them. The dissemination of knowledge of interest to all need not be left to chance.

In the same way, if you learn of the death of a member of the Radiological Society of North America, write to the Editor of RADIOLOGY at once that suitable editorial comment may be made while it is still timely. Ours is a far-flung Society, and RADIOLOGY is our central organ. We should not have to wait for the Annual Meeting to learn that So-and-so, whom we liked well, has slipped from our group.

Even in this day of news reels and candid cameras, radiological specialists and physicists go about their work quietly: a record of their achievements and vital facts concerning them belong in their own journals rather than in the public press. Associated Press, please do not copy.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgement of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CLINICAL ROENTGEN THERAPY. Edited by ERNST A. POHLE, M.D., PH.D., F.A.C.R., Professor of Radiology, Chairman, Department of Radiology and Physical Therapy, in the University of Wisconsin. Madison, Wisconsin. Foreword by GEORGE W. HOLMES, M.D., Roentgenologist to the Massachusetts General Hospital and Clinical Professor of Roentgenology in Harvard Medical School, Boston. A volume of 819 pages, with 199 engravings and a colored plate. Published by Lea & Febiger, Philadelphia, 1938. Price: $10.00.

POLISH REVIEW OF RADIOLOGY. Volume 12. Official Journal of the Polish Society of Medical Radiology and Physiotherapy. Edited by DR. W. ZAWADOWSKI, Warsaw, Poland. Published by Nakl. Polskiego Lekarskiego Tow. Radiol. I. Fizjoterap, Warsaw, 1937. Price not stated.

BOOK REVIEWS

RADIUM LOST AND FOUND. By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R., with an introduction by GEORGE E. PFAHLER, M.D., Sc.D., D.M.R.E. (Camb.), F.A.C.R. A monograph of 77 pages, with numerous illustrations by Mercedes Hoshall, B.F.A. Published by John J. Furlong & Son, Inc., Charleston, South Carolina. Price: $2.00

This small book, written and privately published by Doctor Taft, supports the adage that good things come in small packages. There is an excellent introduction by the eminent Doctor George E. Pfahler. The author makes this tremendously important subject as exciting as a search for buried treasure in sunken galleons, even though the quest for lost radium is most often conducted in sewers and city dumps. While the intrinsic value of the lost element is one phase of the search, the serious physical harm to ignorant persons who come into possession of lost radium is emphasized. One hundred and seven cases of lost radium which occurred in widely separated parts of this country are summarized. Theft played a negligible rôle in the losses but occasionally occurs, as in Taft's story of the man discovered playing a phonograph record with a lost radium needle. In most of the cases, loss occurred through negligence and the radium was flushed into the plumbing or thrown into the incinerator. The evolution of the electroscope into the more refined and efficient Geiger-Mueller counter is described, and references to more detailed articles by the author concerning the construction of the latter instrument are given.

The book is written in a humerous vein which makes reading it a delight, and it is well illustrated with amusing drawings. Whimsical and instructive, this little volume should be required reading for all technicians and nurses who handle radium. Its study would serve to prevent much of the loss, worry, and work connected with the search for and recovery of lost radium.

DAS VENTRIKULOGRAMM (The Ventriculogram). By ERIK LYSHOLM, Dozent für Medizin, Radiologie, BERTIL EBENIUS, and HANS SAHLSTEDT, Assistenten am Röntgeninstitut. Part II, DIE SEITENVENTRIKEL (The Lateral Ventricles). Supplement XXV, Acta Radiologica. A volume of 199 pages, with 284 illustrations. Published by P. A. Norstedt & Sons, Stockholm, Sweden, 1937. Price: 15 Kr. ($4.20).

Although this monograph is identified as Part II of Lysholm's series on ventriculography, it is the last of a group of three volumes to appear. This phase of the subject has been considered in the same concise and practical manner as in the antecedent volumes. Collectively these three volumes constitute the most practical and informative text on ventriculography that has appeared in any language. American readers will find the German text easy to translate and well worth the effort involved.

To facilitate the discussion of tumors affecting the lateral ventricles, Lysholm has classified the material in the following manner:

(A) Convexity tumors (without displacement of the temporal horns)
  I. Medial or Parasagittal Tumors

Group I: Anterior frontal tumors Group II: Posterior frontal tumors	originating from the anterior one-third of the longitudinal sinus
Group III: Fronto-parietal tumors Group IV: Parietal tumors	originating from the mid one-third of the longitudinal sinus
Group V: Occipital tumors	originating from the posterior one-third of the longitudinal sinus

  II. Lateral Tumors (including tumors of the fissure of Sylvius)

(B) Basal Tumors (including temporal tumors)
  I. Subfrontal
  II. Supra- and intrasellar
  III. Anterior temporal
  IV. Posterior temporal

(C) Central Tumors (from the corpus striatum, thalamus and their immediate vicinity)

(D) Intraventricular Tumors

(E) Tumors originating from the septum pellucidum and corpus callosum.

Each classification and group is discussed individually, giving significant statistics, general ventriculographic characteristics, and summaries of typical cases together with ventriculograms and tracings. It is difficult to see how this important subject could be presented in a more logical and instructive manner. The illustrations are excellent and the whole manner of presentation is a tribute to a good teacher who knows his subject.

TRAUMATISMES DU PIED ET RAYONS X (Traumatisms of the Foot and the X-rays). By ETIENNE DESTOT. Preface by Dr. ALEXIS CARREL. Second Edition. A volume of 292 pages, with 156 figures. Published by Masson et Cie, Paris, 1937. Price: 45 fr.

This volume was first conceived and written by Destot some years ago. He, having died in 1918 at Chatillon-sur Seine, the material laid unpublished. With the permission of Madame Destot, Gallois and Japiot have edited the material, the text being as nearly as possible as originally written, these pupils of Destot having added only some roentgenograms.

The author first gives an extensive discussion of the bony anatomy of the foot and leg, then goes on to a rather extensive classification of fractures of the malleoli. This is followed by a chapter in which he discusses the pathogenesis of these fractures and a discussion of the acute fractures of this region. This subject is very extensively discussed and while the terminology and nomenclature used are somewhat at variance with ours, yet the subject material is there and well presented and illustrated.

The author then goes on to a discussion of old fractures about the ankle. The various

types of deformity are discussed at length and well illustrated. In addition, the writer discusses the trouble following fractures of the malleoli without bony deformity.

The text then goes on to a discussion of fractures of the posterior tarsus, that is, astragalus and calcaneum. Here again a thorough discussion of the anatomical and physiologic facts and factors precedes the pathologic material and is well presented. This is followed by a chapter on fractures of the scaphoid and one on dislocations of the astragalus and then fractures of the os calcis. Finally, a chapter is devoted to the injuries of the anterior tarsus.

For anyone interested, particularly in fractures and especially for anyone particularly studying fractures of the ankle and foot, this book will serve as an excellent reference work, giving, as it does, a rather complete study of the fractures encountered in this region, their complications, and a word about their treatment.

X-RAYS AND RADIUM IN THE TREATMENT OF DISEASES OF THE SKIN. By GEORGE M. MACKEE, M.D., Professor of Clinical Dermatology and Director of Department of Dermatology (Skin and Cancer Unit), New York Post-graduate Medical School and Hospital, Columbia University; Consulting Dermatologist, St. Luke's Hospital. Third Edition, thoroughly revised. A volume of 830 pages, with 308 engravings, 31 charts, and 2 colored plates. Published by Lea & Febiger, Philadelphia, 1938. Price: $10.00.

The third edition of this text has been completely revised and the various phases of physics, biological effects, and therapeutic application of x-rays and radium in dermatology are discussed by a group of collaborators as well as by the original author.

The first two chapters by MacKee deal with the history of roentgen rays and radio-active elements. In the next seventeen chapters the physics of radiation are discussed by Quimby and Cipollaro, the majority of the work being presented by Quimby. I believe this portion of the book is of value to the radiologist rather than to the dermatologist since it covers a scope of radiation physics that is more important to the radiologist. In addition to the physics of radiation, the biological and biochemical effects of radiation are presented by Quimby. Desjardins discusses, in two chapters, the effects of x-rays and radium on animal organs and tissues, and also the action of x-rays and radium on pathologic tissue. The author discusses radiodermatitis, its clinical appearance and its treatment. Montgomery has written the chapter on the pathologic histology of radiodermatitis and it contains very excellent plates showing the acute and chronic stages of this condition. The author discusses in a short chapter the question of idiosyncrasy to irradiation.

The remainder of the text, covering some 373 pages, pertains to the practical application of x-rays and radium in the treatment of dermatologic conditions. This part has been contributed by the author as well as the following collaborators: Niles, Lewis, Wise, Cipollaro, and Grauer. A wide variety of cutaneous lesions amenable to radiation therapy are ably presented, and certainly warrant the attention of the dermatologist. The last chapter has been written by Harold Bouton, LL. B., who discusses the medico-legal relations of roentgen and radium therapy.

I believe this text to be an excellent survey of the application of roentgen rays and radium in the treatment of cutaneous diseases. It contains a valuable discussion of the physics and biological effects of roentgen rays and radium. It can be highly recommended to the radiologist as well as the dermatologist.

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S. RICHARD BEATTY, M.D., of Madison, Wis.
G. E. BURCH, M.D., of New Orleans, La.
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GYNECOLOGY AND OBSTETRICS

Kymographic Insufflation of the Tubes. L. Bonnet. Presse méd., May 12, 1937, **45**, 715–717. (Reprinted by permission from British Med. Jour., Aug. 7, 1937, page 23 of Epitome of Current Medical Literature.)

The author is of the opinion that kymographic insufflation of the tubes is a procedure which is of value in obtaining records of the intratubular pressure during insufflation. By this means the permeability of the tubes can be ascertained and records of the contractions of the tubes obtained, making possible an estimate of their functional capacity and to some extent that of the ovaries. In cases of tubular sterility insufflation has been the first procedure, followed by the injection of lipiodol in doubtful cases or when the exact position of the obstruction must be known for surgical treatment. It has been found, however, that kymographic insufflation gives even better and more detailed information than does lipiodol injection. During insufflation of a normal tube by a current of gas, rhythmical peristaltic movements can be registered and variations of pressure recorded on the drum. If the tube is permeable the graph shows a series of more or less irregular oscillations with a pressure of from 60 to 70 mm. of mercury—never above 100 mm. When the tube is obstructed the passage of gas is stopped when the pressure reaches 200 mm. of mercury. When tubular spasm occurs the pressure passes 100 mm. and may reach 200 mm., but as soon as the spasm ceases the pressure falls rapidly until the oscillations are similar to those of a normal tube. In cases in which a tube is stenosed, either by lesions of the mucosa or by peritubular adhesions or torsion, the pressure rises to 100 or 200 mm. of mercury and then falls gradually with little or no oscillation. From these results it has been possible to evaluate ovular function, which is in direct relation to tubular function. A case of ovarian insufficiency showed a pressure of only 10 mm. of mercury, but after x-ray or radium treatment the number and amplitude of the oscillations increased markedly. Following insufflation of tubes not completely obstructed, pregnancy resulted in nearly 25 per cent of cases.

Short Wave Therapy in Gynecology. H. Korb. Strahlentherapie, 1937, **60**, 615.

The author describes a special table for short wave therapy with condenser electrodes. Measurements showed that the skin temperature was raised from 29.5 to 36.8 degrees C., and the temperature within the body to 37.4 degrees C.

ERNST A. POHLE, M.D., Ph.D.

Adnexal Tuberculosis. T. Heynemann. Zentralbl. f. Gynäk., March 27, 1937, **61**, 738–744. (Reprinted by permission from British Med. Jour., June 5, 1937, p. 91 of Epitome of Current Medical Literature.)

The author has found neither in his own investigations nor in the literature a single case in which vaginal (conjugal) infection has been proved to be the cause of adnexal tuberculosis. The reported cases break down either because a thoracic focus has not been excluded radiographically or because it has been forgotten that acid-fast bacilli in the semen of a male suffering from urogenital tuberculosis may be smegma bacilli, and that therefore only animal inoculation tests are conclusive.

He states that experience has now convinced most gynecologists that conservative treatment, although requiring at least six months, is better and less risky than surgery: an adjuvant is found in x-radiation, which, however, because of the danger of castration, is justified only in the worst cases. Operative treatment is called for only (1) when the diagnosis is obscure, (2) for simple opening of an abscess, (3) when the patient demands it for persistent fistula. Regarding operation as dangerous and to be avoided whenever possible, Heynemann, to ensure a diagnosis, advocates puncture of the pouch of Douglas. Two positive results after animal inoculation and one finding of tubercle bacilli have previously been described after this procedure.

Heynemann reports having tried it in eleven patients, with five positive and five negative correct results, and one incorrect one in which no fluid could be aspirated. Since smegma bacilli have been found by Simmonds in an adnexal tumor, animal inoculation results are more reliable than those of smears. A positive finding, in Heynemann's opinion, is a contra-indication to operation.

Heat Effect and Results of Short Wave Therapy in Gynecological Diseases. H. Guthmann and M. Reitz. Strahlentherapie, 1937, **60**, 582.

In investigations conducted on models and the human being, a wave length of from 5.5 to 6.5 meters proved to be most effective. The temperature increase in fat was approximately 300 per cent higher than in flesh. Condenser electrodes were superior to plate electrodes. There was no relationship between the wave length and the output of the apparatus as far as the optimal temperature increase is concerned. Comparative temperature determinations in urethra, vagina, and rectum showed that the temperature increase is highest in the rectum and lowest in the vagina. Leukocytosis had no influence on the degrees of temperature increase obtained during the treatment. One hundred twenty-three cases of pelvic inflammatory disease were carefully analyzed. The most striking response was seen after the first six sittings. Thirty cases were cured, 46 greatly improved, 47 improved, and not a single case showed an untoward effect from the treatment.

ERNST A. POHLE, M.D., Ph.D.

Present-day Problems of Short Wave Therapy in Gynecology. I. v. Kövesligethy-Büben. Strahlentherapie, 1937, **60**, 541.

The author reports his experience with short wave therapy in the treatment of 557 cases in the Women's

Clinic at the University of Budapest. Of the 311 cases of pelvic inflammatory disease, 102 were acute and subacute and 209 chronic. Of the first group, 80 per cent were cured and of the second group 67 per cent. The condenser field method was used with the electrodes at 5 to 10 cm. from the skin. Applications varied from 5 to 20 minutes, depending on the acuteness of the inflammation.

A study was also undertaken in order to determine the effect of short wave therapy on menstruation. Seventy-eight test cases were used: in 72 per cent the period was normal, in 14 per cent there was slightly more bleeding, and in 12 per cent the period lasted longer. It is concluded, therefore, that short wave therapy is not contra-indicated during the menstrual period. Ninety-six cases of dysmenorrhea were also treated and in 70 per cent there was improvement or cure. Individualization of the therapeutic approach is important and the dosage must be carefully controlled.

ERNST A. POHLE, M.D., Ph.D.

Spontaneous Separation of Symphysis Pubis. C. Schaap. Nederl. Tijdschr. v. Geneesk., May 29, 1937, pp. 2510–2514. (Reprinted by permission from British Med. Jour., July 24, 1937, page 16 of Epitome of Current Medical Literature.)

The author, who records an illustrative case, states that spontaneous symphysiolysis is a very rare occurrence. Wishne and Mayer quote three series of statistics according to which it was seen only once in 30,000 deliveries, four times in 80,000, and three times in 94,000. During pregnancy, owing to the increased blood supply in the pelvis, the ligaments of the different joints become loose, so that an increased mobility of the symphysis and sacral joints develops, and the symphysis can be moved 5 mm. in a horizontal and vertical direction. The symptoms are as follows: (1) There is pain in the symphysis and lower part of the back, sometimes radiating down the thighs; (2) the patient is unable to lift or move the legs, and (3) she has a waddling gait. These symptoms are so characteristic that the diagnosis can be made without x-ray examination. Treatment should always be conservative, consisting of absolute rest in bed for from four to six weeks according to the severity of the case. Schaap's patient, in whom spontaneous symphysiolysis occurred during delivery, was a woman, 25 years of age, in whom spontaneous necrosis had occurred in the mesial sesamoid bone of the left hallux a year previously.

HEART AND VASCULAR SYSTEM

Roentgen Therapy of Active Rheumatic Heart Disease: A Summary of Eleven Years' Experience. Robert L. Levy and Ross Golden. Am. Jour. Med. Sci., November, 1937, **194**, 597–601.

The authors studied 48 patients with rheumatic heart disease who were treated by roentgen irradiation and observed for eleven and one-half years. They found evidence of improvement in a large number of these patients; those receiving the largest doses were most benefited. Irradiation relieved cardiac pain in patients who did not have aortic insufficiency. There were no harmful effects noted, although unpleasant radiation reactions appeared in about one-half the cases. The patients with low grade activity and free from any evidence of congestive heart failure fared best. The nature of the benefits produced by irradiation therapy is unknown. The method promises to be of some significance in the treatment of properly selected cases.

G. E. BURCH, M.D.

Right-sided Descending Aorta. G. Soleil. Bull. et Mém. Soc. Radiol. Méd. de France, January, 1937, **25**, 15, 16.

A case of right-sided descending aorta is presented which is evidently not due to congenital anomaly, but to a combination of syphilitic aortitis with elongation and a left kyphoscoliosis.

S. RICHARD BEATTY, M.D.

Aortic Calcification Simulating Ureteral Calculus in a Case of Renal Lithiasis. H. Tillier. Bull. et Mém. Soc. Radiol. Méd. de France, February, 1937, **25**, 144, 145.

The author presents a case to demonstrate the possibility that calcified plaques in the aorta may simulate ureteral calculi.

S. RICHARD BEATTY, M.D.

Auricular Fibrillation in the Kymograph. H. Ludwig. Röntgenpraxis, November, 1936, **8**, 731.

Auricular fibrillation can be seen in kymographs of the left ventricle. A case is described in which very small flutter-like excursions could be seen in the entire area of the left and right auricles. They corresponded in frequency with the auricular contractions in the electrocardiogram.

HANS W. HEFKE, M.D.

Cardiovascular Complications. H. Bartsch and G. Wachner. Klin. Wchnschr., May 22, 1937, **16**, 743–746. (Reprinted by permission from British Med. Jour., Aug. 14, 1937, page 27 of Epitome of Current Medical Literature.)

The authors describe the effects on the cardiovascular system which they were able to observe in a large proportion of cases of carcinoma of the pharyngolaryngeal region treated by Coutard's method of protracted and parcelled deep x-radiation. The complications were caused by the toxic products of the irradiated tissues, and manifested themselves in myocardial degeneration and disturbances of the cardiac rhythm. The fall of the blood pressure and the acceleration of the pulse may lead to coronary insufficiency in cases predisposed to angina pectoris. The authors, therefore, advise careful observation of the cardiovascular system and appropriate prophylactic measures in all cases treated by Coutard's method.

THE HIP JOINT

Congenital or Infantile Dislocation of the Hips. Edward C. Vogt. Am. Jour. Roentgenol. and Rad. Ther., January, 1937, **37,** 21–27.

The roentgen findings and diagnosis are not as typical as some have stated, but are so after some time has passed. In a review of 259 cases, the youngest child was eight days old. In normal cases, a line drawn along the inferior border of the rami of the os pubis and ischium, if prolonged outward in the same curve, will fall in line with the inferior surface of the neck of the femur, whereas in the dislocated, the line meets the shaft lower down. The flattening of the upper portion of the acetabulum appears in two months or less from pressure of the misplaced head. The shallowness again is due to absence of normal femoral head pressure.

The author feels that the deformity is a post-natal development due to an inherent relaxation of ligaments and tendons, predominant in females with a hereditary and familial tendency; the bone and joint changes are secondary and cannot be demonstrated at birth. Trauma may play a part in that 40 per cent of these reviewed were either breech or instrumental deliveries.

When reduced very early the bone and joint contours may return to a perfectly normal condition. When diagnosis cannot be definitely made, repeated examinations are advocated and treatment instituted as if there was definite dislocation.

S. M. Atkins, M.D.

Infantile Coxitis and its Sequels. S. C. Iversen. Hospitalstid., June 8, 1937, **80,** 629–652. (Reprinted by permission from British Med. Jour., Aug. 21, 1937, page 30 of Epitome of Current Medical Literature.)

The author has examined 16 children and 13 adults who had suffered from an apparently non-specific coxitis characterized by pain, fever, swelling, and fixation of the hip, usually accompanied by abscess formation, during the first year of life. The examination of these patients many years after the onset of their disease revealed profound anatomical and radiological changes, with corresponding deformities and functional disturbances; the movements about the hip were seriously impaired. All the patients limped as a result of shortening of the affected limb, dislocation at the hip, limited range of movement, ankyloses, contractures, weakness of certain muscles, or secondary changes in the knee, ankle, or other joints. To a shortening of from 2 to 4 cm. about the joint itself could be added the shortening due to adduction and atrophy of the femur, so that in several cases there was an effective shortening of as much as 9 cm. In as many as 22 cases the hip was dislocated, the great trochanter resting against the iliac crest. These patients were in a worse condition than the subjects of congenital dislocation of the hip, whose gait closely resembles theirs. In spite of their deformities they were able to lead an active life, and some could bicycle and skate. The dominating disturbance in adults was pain, and they all complained of this. It radiated down the leg, but seldom to the back as is the case with congenital dislocation of the hip. The author's remedies include early operative intervention, with incision of abscesses and the readjustment of the head of the femur in infancy.

The Radiographic Appearance of the Pseudo-cysts of Coxarthritis. F. Francon. Bull. et mém. Soc. de Radiol. méd. de France, October, 1937, **25,** 656, 657.

Studies of radiographs and of anatomical sections led the author to believe that the honeycomb-like pseudocystic appearances in coxarthritis are due to small infarcts in the bone.

S. R. Beatty, M.D.

HISTORADIOGRAPHY

Possibilities of the Extension of Methods of Microanalysis by Historadiography. Paul Lamarque. Bull. et Mém. Soc. Radiol. Méd. de France, January, 1937, **25,** 51–53.

The coefficient of absorption of a substance for x-rays is a function of the wave length, but there are certain irregularities due to the critical wave lengths. The coefficients of absorption are known. If it is possible to discover the critical wave length for an unknown substance, we can determine its nature. By taking historadiographs with roentgen rays of varying wave lengths it will be possible to discover the critical wave length for the unknown substance by determining those wave lengths for which absorption is complete and for which it is not. The method will probably have many practical difficulties.

S. Richard Beatty, M.D.

HODGKIN'S DISEASE

Hodgkin's Disease. H. Prinz. Zentralbl. f. Chir., June 19, 1937, **64,** 1461–1469. (Reprinted by permission from British Med. Jour., Aug. 7, 1937, page 21 of Epitome of Current Medical Literature.)

According to Prinz, a large mediastinal tumor as an early manifestation in Hodgkin's disease is rare. However, it may occasionally cast a large x-ray shadow or even deform the chest wall before diagnosis is possible from enlargement of the lymph glands and spleen, together with irregular pyrexia and the results of biopsy. He relates the case of a girl, aged 15, in whom an anterior mediastinal swelling pushed forward the second and third left ribs; at operation for supposed primary neoplasm a tumor the size of a fetal head and weighing 315 gm. and adherent to the pericardium, left pleura, and chest wall was removed, with the exception of substernal prolongations adherent to the arch of the aorta and great veins. Microscopical examination showed it to consist of lymphogranulomatous tissue, to be rich in plasma cells and eosinophiles, and to contain giant cells embedded in connective tissue. Deep x-ray treatment was subsequently carried out, and the patient recovered after 15 months. No lymph gland swelling was noted before or after operation.

INFECTION

Roentgen Treatment of Infection from Human Bite. R. Manges Smith and Willis F. Manges. Am. Jour. Roentgenol. and Rad. Ther., November, 1937, **38,** 720–726.

In a group of nine cases of this type, x-ray radiation has produced uniformly good results. In view of the seriousness of many of these cases, in that the average hospitalization is from 45 to 54 days, with death occurring occasionally, and since x-ray radiation both in the acute and chronic cases shortens the disease, this form of treatment should be employed. It does not interfere with surgical procedures. Pain usually decreases in a matter of hours. Roentgen prescription consists of superficial therapy of from 75 to 100 r over the lesion or glands, repeated in from 24 to 48 hours if necessary.

S. M. Atkins, M.D.

THE INTESTINES

Radiologic Images of Small Intestinal Obstructions without Organic Obstruction. Jean Berger, Gally, and J. Mialaret. Arch. d. mal. de l'app. digestif, November, 1937, **27,** 959, 960.

The authors present a case in which there was radiographic evidence of small intestinal obstruction but in which a laparotomy revealed no evidence of any abnormality accounting for this appearance.

S. R. Beatty, M.D.

Intestinal Obstruction in a Fifteen-year-old Youth Caused by a Persistent Omphalomesenteric Duct. Roberto Pérez Díaz, Rafael Ramírez Léon, and José Abay. Medicina de Hoy, March, 1937, **2,** 148–153.

The authors report the case of a 15-year-old boy who, apparently in perfect health, developed sudden acute abdominal pain, followed by vomiting, muscular rigidity, and cutaneous hyperesthesia, especially over the right iliac fossa, pulse of 54, temperature 36.2°, dry tongue, pale skin, and profuse sweating; blood count not given. A diagnosis of acute appendix was made and an emergency laparotomy done. When the abdomen was opened, dilated loops of intestines suggested obstruction. A loop of the ileum was found strangulated by a persistent omphalomesenteric duct. Division of the duct relieved the obstruction.

A. Mayoral, M.D.

The Postural Treatment of Infant Colic. William Snow. Am. Jour. Roentgenol. and Rad. Ther., November, 1937, **38,** 779, 780.

From the fact that colic in infants before three months of age was found to be accompanied by considerable gas in the small intestine, the author placed the infants in the semi-inclined, right lateral, and abdominal positions, so that the gas would rise to the cardiac end of the stomach, and found the colic disappearing.

Fifty infants were examined roentgenologically in the recumbent position during the first week of life, and 25 showed gas in the small intestine. Twenty-five were then kept in a semi-inclined position, so that the esophagus was on a higher plane than the pylorus, and in 22 the small intestinal gas disappeared. It would be advisable, therefore, in all infant colic cases to place the child in the positions mentioned to relieve the condition.

S. M. Atkins, M.D.

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